DÆDALUS

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Robert Oppenheimer
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Charles Morris
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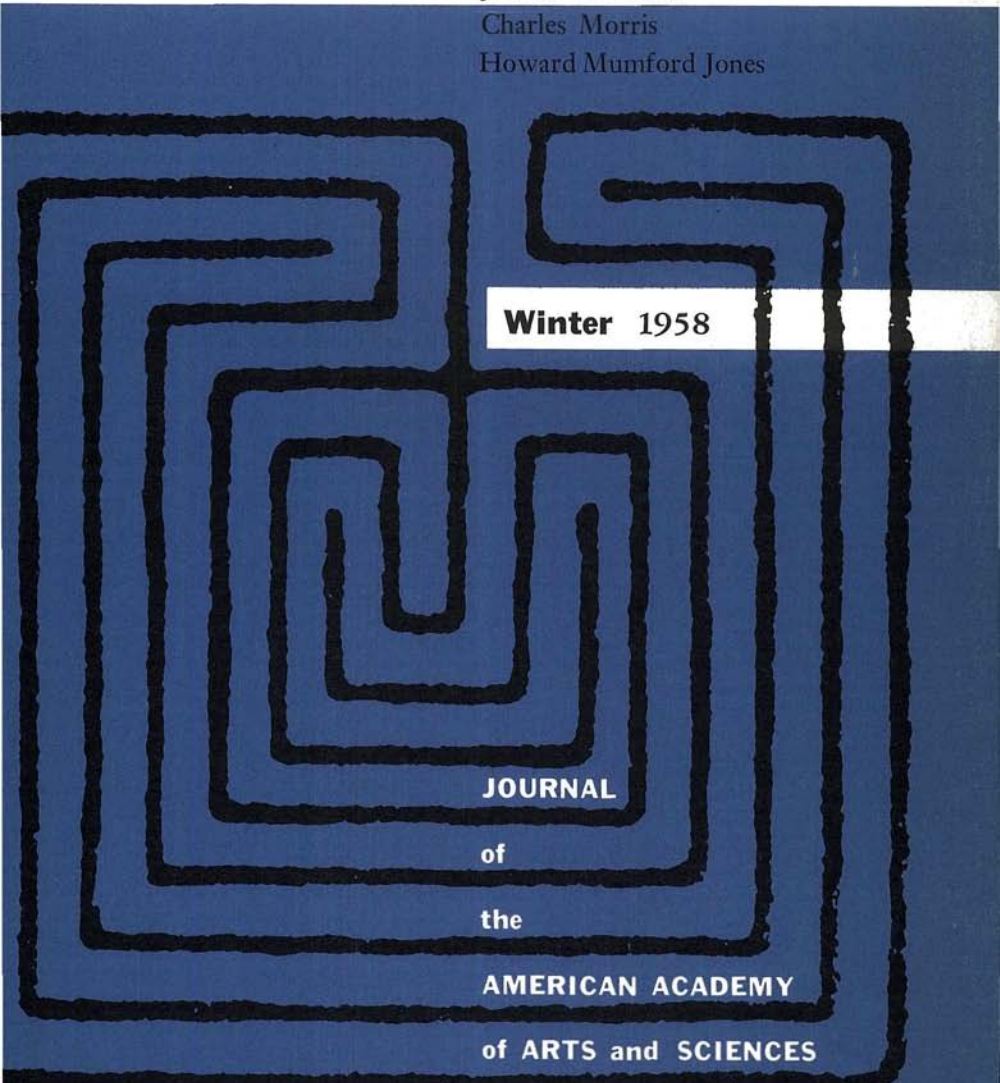
NCE AND THE MODERN WORLD VIEW



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DÆDALUS

Journal of the American Academy of Arts and Sciences

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Perspectives on the Issue "Science and the Modern World View"

GERALD HOLTON

WITH THIS issue, *Dædalus* continues its ascent to the goal which clearly beckons: to give the intellectual community a strong voice of its own.

The journal is now to be a quarterly and a medium through which leading scholars in all fields can address one another. This plan is as unique as it is timely. As a by-product of the gratifying successes obtained with our refined tools of specialization, fruitful communication between members of different sections of the learned community is now widely held to be increasingly difficult; a small but growing group even considers it increasingly unnecessary. The very structure of our professional allegiance emphasizes the differences between fields. In this situation *Dædalus* can serve as an instrument for focusing our attention again on that which does or should make us members of one community.

Thus the journal aims to represent the world of the intellectual, first of all to himself. Here he shall continue to encounter the quality and range of activities which engage scholars everywhere. The requirement of internal unity may give prominence to some one field in each issue. But in the long run our attention encompasses the full range of our interests – the humanities, the sciences, the social studies, and public affairs. We may hope that these individual acts of attention have the cumulative effect of widening the horizon of our respect. Gyorgy Kepes' choice for our cover design, the motif of the labyrinth seen from above, epitomizes what *Dædalus* may do: lift each of us above his cell in the labyrinth of learning in order that he may see the entire structure as if from above, where each separate part loses its comfortable separateness.

This basic editorial policy raises also some problems for *Dædalus*. One problem lies in the long incubation period of good contributions. Another is the danger of falling into the extremes of technical jargon on the one hand or of popularization on the other. For

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there appears to be a law of inverse proportionality connecting the amount of valid information with the size of the expected audience in the usual media of communication: when the story is told on the level of the professional journal, it can be understood by only a small number of fellow experts; and when it is told through the mass media so that anyone may understand what is said, the meaningful content is often seriously diluted.

With its unique readership, as distinguished and versatile a nucleus as has any journal in the country, *Dædalus* can try to develop another approach to communication. Here the specialist can present an aspect of his field – whether it be physics, economics, or history – to specialists in other fields, who will demand of the author only that his account be not obscured by undue allowance for his audience. The influence of *Dædalus* on the greater society, on the public at large, will be determined entirely by its impact on this smaller group.

In the main part of the present issue, nine scholars in the humanities, sciences, and social studies present a spectrum of current opinion on the topic *Science and the Modern World View*. It is one of the great problems, of this age and of every age. As David McCord reminded us not long ago, the ancient figure of Dædalus himself has always been strangely modern, standing at the intersection of old dreams and new nightmares. He is remembered for his cunning, for the invention of devices no one else could duplicate or even understand. He mastered knowledge of the natural order, of technological possibilities, of magic itself. Today, this combination reappears in the popular conception of the scientists. And the same image contains a second confusion no less dangerous – that a true synthesis of the sciences and arts can still be achieved at the highest level within the individual. As these nine essays affirm, there may be real hope for reaching a common understanding, but not by the imposition of a new system from without to replace the unified world systems we have lost. Rather, the way to the goal is precisely through discussions such as these. As Robert Oppenheimer says, "We ourselves, and with each other by our converse, can create, not an architecture of global scope, but an immense, intricate network of intimacy, illumination, and understanding."

The essays examine the influence of science upon our world conception in three groups, placed in a chronological sequence. In

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the first group Henry Guerlac, Harcourt Brown, and Giorgio de Santillana consider the manner in which the rise of science in the seventeenth century affected the culture and world view of the following century. The study of this historic case serves two purposes: to assure us that present problems have been faced before, and to examine the origins of our contemporary outlook. In his introductory remarks at the Academy Conference devoted to these papers, Ernest Nagel said:

> It is eminently fitting that we should begin the evaluations of the import of the scientific revolution for a viable outlook on the place of man in nature with the examination of a similar situation that confronted our civilization two centuries ago. The scientific foundations of what is, in the main, still the educated man's outlook on the universe and on his fellow-beings were laid in the seventeenth century. It is, of course, a commonplace of modern historical scholarship that the achievements of the "century of genius" were continuations of speculations that had been cultivated much earlier. Nevertheless, it was not until these earlier speculations were given the remarkable formulations, extensions, and detailed applications by the great seminal minds of the seventeenth century that those conceptions became a serious challenge to pervasive and hallowed beliefs and modes of thought.
>
> How serious this challenge was did not become fully apparent immediately, and in retrospect we can see that it was the major task of eighteenth-century philosophical thinkers to make evident the import of seventeenth-century science for traditional views of nature and man, and to reinterpret and adjust the dominant humanistic heritage in response to the apparently disruptive implications of the new scientific ideas which were percolating into the thoughts of Everyman. We have, I believe, something to learn from the experience of our predecessors in the seventeenth and eighteenth centuries that has relevance to our own special concerns. At the very least, what we can learn from that experience can provide us with a useful and liberating perspective for assessing the current debates over the relations between the sciences and the humanities.

Building on the historical study in the first essays, the next three concern themselves with the contemporary scene. Philipp Frank, Robert Oppenheimer, and Jerome S. Bruner direct their attention toward the key concepts of science which have undergone profound changes in the last two or three generations, and the conflict implied between the new conceptions and the old bases of the current world view. The revolutions in science in our time have destroyed not only the validity of the old outlook but even the old vocabulary itself. The full trauma of this development

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is just beginning to be felt. For the first time in history, the intellectual finds himself abandoned in a universe which he does not comprehend. And yet, specific and hopeful prescriptions can be found. The new image of the factual world must, of course, be introduced into the larger concern of all thoughtful men; but, in addition, as the authors show, the scientific developments themselves carry the seeds for a crystallization of new unities – for example, in the therapeutic effect which successful scientific discourse can have on all discourse, and in the discovery of greater continuity and order which is emerging from the earlier chaos of smaller patterns.

In the last three articles, P. W. Bridgman, Charles Morris, and Howard Mumford Jones look to the future. They reject the opinion, held by a number of influential spokesmen, that the sciences and humanities are of necessity in detrimental conflict. But they also hold out little hope for a discovery of some master-plan for fitting into one pattern our separate preoccupations. And this sums up both the triumph of modern thought and its despair. A synthesis on a large scale is possible neither within the individual person nor among the several fields of learning. But as a consequence the need is greater than ever to recognize how small one's own portion of the world is, to view from one's own narrow platform the search of others with interest and sympathy, and so to re-establish a learned community on the recognition that what binds us together is mainly, and perhaps only, the integrity of our individual concerns.

These nine related essays, and the Academy Conference at which they were presented with the partial support of the National Science Foundation, were assembled in honor of Dr. P. W. Bridgman and Dr. Philipp Frank on the occasion of their retirement from active teaching at Harvard University. As scientists and philosophers and as teachers, colleagues, and friends, Dr. Bridgman and Dr. Frank have both been enlightening and stimulating to scholars in many fields and in many countries. While their respective contributions lie in different areas, they share this characteristic: through his work each has gained wide respect among scientists and humanists, whether these have always agreed or (as perhaps was sometimes intended) by disagreement have been led into further exploration. Thus the topic of the Conference reflected the fact that the region of interest in which both men overlap

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is not any single scientific or philosophic problem but the eloquent and persistent exposition of a broad view of science.

Both men refused to sanction a ceremonial *Feier*, and at their request none of the papers was devoted specifically to their work; rather, the character of the meeting honored them. The generous and warm participation of the nine authors and of the invited audience of about 250 persons helped to make the meeting a memorable occasion.

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Three Eighteenth-Century Social Philosophers: Scientific Influences on Their Thought

HENRY GUERLAC

WE HAVE been asked to discuss "the manner in which the rise of science in the seventeenth century affected the culture and world view of the eighteenth century." I should like to raise the question of how great a 'common understanding of science,' and of its meaning for man, the eighteenth century possessed, by taking up briefly three well-known social philosophers of the Enlightenment: Montesquieu, Voltaire, and the Baron d'Holbach. I propose to examine whether an interest in science was in each case a chief influence upon, or a principal source of, their social philosophy; and to ask whether science meant the same thing to each of them, and to what extent Newton, whose name and accomplishments are so frequently invoked by the *philosophes* and their historians, provided a common inspiration.

I

Of Montesquieu, the first of my triad, I shall speak less fully than he deserves, for he was surely one of the most original, if not perhaps the most influential, minds of his century. Montesquieu's scientific interests were the avocation of his early manhood, when as a young magistrate of Bordeaux in the 1720's he was active in the affairs of the town's Academy. From the scientific juvenilia of this period; from the later entries in his workbook, the *Pensées*, and from his masterpiece, the *Esprit des lois*, a rather clear picture emerges of the scientific warp of his thought and of the motives that engendered this passing enthusiasm.[1]

Like his contemporaries, the young Montesquieu was moved by pride and wonder at the scientific accomplishments of the seventeenth century, which had cleared away so many superstitious beliefs and offered such a precise and simple picture of the

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world around us. But to Montesquieu, science was less significant as a remedy for the disease of credulity and superstition, less valuable because of the useful applications which might flow from it, than as a dramatic proof of the power of the human mind. For the man of humanistic training like himself, he saw a task of special urgency: to civilize and domesticate the recent discoveries of science, and fit them into place in the great heritage of humane learning, by removing that artificial barrier which technical jargon, poor writing, a dry and forbidding language, had erected. But for the bolder purpose which began to shape itself in his mind, he might well have sought to emulate Fontenelle, whom he so much admired, and have anticipated Voltaire as a humane expositor of the natural sciences. Instead he took a more fruitful path, that of attempting to demonstrate in a work of great erudition and creative power that science and humane learning could be combined in a search for the *Spirit of the Laws*. For nothing is more characteristic of Montesquieu than his conviction that all spheres of man's knowledge are compatible and harmonious; that "all the sciences are good and support each other."[2]

If the facts and conclusions of science, as Montesquieu understood them, contributed less to the *Spirit of the Laws* than he surely hoped, the general spirit of scientific inquiry was, for perhaps the first time in history, invoked in the study of man in society. Cool objectivity, detached relativism, painstaking accumulation of fact and observation in support of his generalizations – these seem quite clearly to reflect the example of the students of nature. "Observations," Montesquieu once wrote, "are the history of physical science; systems are its fables."[3] If natural science had been remade by adhering to such principles as these – and he might well have drawn them in part from Thomas Sprat's *History of the Royal Society*, a work he admired – could not a science of man emerge from the application to the study of man of these tenets of the New Experimental Philosophy?[4]

It is when we turn to the substance of his scientific borrowings that we are disappointed. Montesquieu remained to his death an unwavering disciple of Descartes, though by the time the *Spirit of the Laws* appeared in 1748 Newtonian views had long since triumphed in France. Montesquieu's physical philosophy – I do not say his physics, for an understanding of the mathematical nature of physics was beyond his capabilities – was Cartesian, strictly

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mechanistic and deterministic. In natural history, physiology and medical theory – the scientific fields which attracted him most – he accepted without question the teachings of the iatro-physical school which had emerged in the wake of Descartes' speculations. Employed in the pages where Montesquieu discusses his theory of the role of climate, this already obsolescent physiology contributes nothing but confusion.

Much has been made of Montesquieu's sweeping definition of laws, "Laws, in the widest sense, are the necessary relations which derive from the nature of things," and of the fact that Montesquieu is the first modern thinker to apply deterministic principles, not only to physical nature, but to man in his social and political life. For this – as much as for his more empirical side – the founders of sociology, Comte and Durkheim, mark him as a precursor.[5]

Yet it is Cartesian dualism, the dichotomy between mind (or soul) and body, between *l'homme physique* and *l'homme moral*, which is the key to Montesquieu's view of natural law as it regulates the conduct of men. While all beings, living or inert, are subject to the inexorable operation of physical law – the laws of the physical world – man is also under a law peculiar to himself; the natural moral law, the law of God, which is perceived by human reason and regulates man's behavior as a rational being. The diverse positive laws of different peoples are the special applications of the general moral law; or, better still, of the moral law as modified by time and place, by historical tradition and local custom, by the wisdom and moral frailty of law-givers, and by the circumstantial operation of physical laws on the minds and bodies of men.

In the sections which are devoted to his famous theory of the influence of climate and topography, Montesquieu tries to show how physical laws interact with and modify the interpretations and applications of moral law.[6] But this scientific ingredient really plays a very small part in Montesquieu's total plan. It is the *moral* law of nature which really concerns him, and this (as we well know) lay ready at hand, expounded in the writings of Stoic philosophers, Roman jurists and Christian theologians.

Montesquieu found the intellectual and moral forces, illustrated by examples of the traditional sort and familiar to anyone steeped in the classics, most useful in explaining the variations of positive law in different times and places. Psychological and social causes – *les causes morales* – are far more important, he

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feels he must warn his reader, than physical and environmental causes, for it is these that mainly determine the character of a people and the laws and institutions under which they live. Just as in an earlier work Montesquieu found the central cause for the rise and fall of the Roman Republic in the changing character of the Roman people, so in his description of different forms of government he discovers for each a psychological determinant or principle: for the Monarchy, 'honor'; for the Republic, 'virtue'; and for Despotism, 'fear.' It is these so-called principles which determine the pattern of laws a people shall have and their decay which threatens the stability of a society.

I believe Montesquieu's scientific veneer contributed less to the *Esprit des lois* than some have supposed. It was from the ready resources of the humanistic scholar – from omnivorous reading in the literature of travel, from his own perceptive observation of men and manners, and above all from his devotion to the Greek and Roman classics – that he drew his wealth of illustration and most of his inspiration. It was from the old, prescientific natural-law tradition and from the bookish riches of 'moral philosophy' – from St. Thomas Aquinas, from Plutarch, Seneca and his beloved Cicero, and of course from Aristotle and the historians of Greece and Rome – that he drew his conceptual framework and his basic outlook.[7] Steeped in the classics from his school days (as were all Frenchmen of this supposedly scientific century) he lived at the Château de La Brède the life of a Roman gentleman, close to his fields and his vines, and inseparable from his magnificent library. It is too much to suppose that the scientific interests of his youth – in which he maintained a desultory, if receding, curiosity all his life – could outweigh his deeper allegiance to the humanities. Montesquieu did not need Pope to tell him that the proper study of mankind is man.

II

It comes as something of a surprise that Voltaire – incredibly versatile man of letters, tireless pamphleteer, and sibylline court jester – should have taken as one of his strongest claims to fame the fact that, as much as any man, he had introduced the French public to the discoveries, the philosophy, and the method of Sir Isaac Newton.

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The trip to England in 1726-1729 first brought to Voltaire's attention the two English thinkers who were to influence so profoundly his life and thought: Newton and Locke. But his full conversion to the physical doctrines of Newton and his rejection of the prevailing Cartesianism took place only after his return to France and was due in large measure to the influence of that gifted blue-stocking and competent Newtonian, the Marquise du Châtelet.[8] Under the eye of the *immortelle Emilie*, and indeed with considerable assistance from the Minerva of France, Voltaire published in 1738 his *Elements of Newton's Philosophy*. Sharing Montesquieu's conviction that scientific discoveries should be humanized and spread abroad, yet disdainful of Fontenelle's cloying sentimentality, Voltaire set out to "remove the thorns" from Newton's writings, "but without loading them with flowers which do not suit them."[9]

The *Elements of Newton's Philosophy* is not precisely the sort of book we might expect. It is not just a simple exposition of Newton's discoveries: of his *System of the World*, of the doctrine of attraction, and of the experiments on light and color. There is, at least in the later revisions, considerable space given to the religious implications of Newtonian thought and the support it accorded to Voltaire's deistical convictions. The chapters on light are not confined to Newton's own discoveries, but include some historical information and a good deal of later material. Most striking is the interest Voltaire displays in the physiology of vision. A chapter on the human eye as an optical instrument is followed by chapters treating the psychology of visual perception, a subject which fascinated Voltaire. Here he draws upon Locke and upon Bishop Berkeley's *New Theory of Vision*.[10] He recounts the famous case of Dr. Cheselden's successful operation on the young man born blind, and elaborates at unnecessary length upon Newton's casual comparison of the colors of the spectrum with the tones of the diatonic scale, a subject of timely interest because of Father Castel's invention of his color organ.

Voltaire's devotion to the sensationalist philosophy of John Locke apparently finds an echo in these passages, and Voltaire seems concerned to emphasize, here as elsewhere, the essential harmony of the doctrines of these two great English thinkers.

To Voltaire, Newton was supremely important for having demonstrated the effectiveness of a new method of mathematico-

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experimental discovery in science, the famous method of analysis and composition. To dissect nature – even, as Hermann Weyl pointed out, the perceptively or intuitively simple, like a beam of white light or the elliptical path of a planet – into constituent elements, and then to confirm this dissection by successfully recombining the elements to restore the original phenomenon: this was the method that Newton not only practiced but here and there elucidated in the *Opticks* and the *Principia.*

Locke (so it seemed to Voltaire) had applied as far as he could the same method. He had laid open to man the anatomy of his mental processes "just as a skilled anatomist explains the workings of the human body."[11] And the conclusions Locke reached – that all knowledge depends upon sense experience; that accordingly most synthetic or a priori thinking is groundless; that much verbal discourse is without meaning – all this supplied Voltaire with a sharp and devastating implement with which to cut down the luxuriant overgrowth of theological assertion and philosophical system.

That Locke had set bounds to the pretensions of the human intellect was for Voltaire his outstanding accomplishment. But it was easy to pursue Locke's clues and end in skepticism, as Hume was to demonstrate. It was possible also to derive from Locke – as did the Abbé Buffier,[12] whom Voltaire read approvingly – the conclusion that all the basic truths to which the human mind habitually gives consent are mere probabilities, excepting only the knowledge of our own existence. But if in philosophy we may perhaps enjoy the indolent luxury of suspended judgment, life requires action, and men – from all time – have acted in accord with probability, which comes nearest to Truth. Voltaire was obviously attracted to this early form of the 'philosophy of common sense'; and I believe he found in Newton's accomplishments a remarkable exemplification of it.

Locke did not draw these consequences except in one significant instance. With respect to the moral sciences, he was confident that man could find a pathway to demonstrative knowledge; but as to the sciences of nature he was wholly pessimistic:

> I am apt to doubt that, how far soever human industry may advance useful and experimental philosophy in physical things, *scientifical* will still be out of our reach. . . . *Certainty* and *demonstration* are things we must not, in these matters, pretend to.[13]

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Elsewhere, he is still more emphatic, asserting that natural philosophy can never become a science, that is, never completely certain, like a theorem in geometry:

> Experiments and historical observations we may have, from which we may draw advantages of ease and health, and thereby increase our stock of conveniences for this life; but beyond this I fear our talents reach not, nor are our faculties, as I guess, able to advance.[14]

The situation with Newton was similar, but also in a manner different. Those eighteenth-century devotees of Newtonian thought who believed that because Newton used a mathematical method he held his conclusions to be eternally valid and perfectly true, like the demonstrations of geometry, had not read their Newton. But Voltaire had, and he well knew that the knowledge gained through the method of analysis did not have the cogency of a geometrical proof. And he was familiar with those passages where Newton admits that the propositions arrived at by induction are "very nearly true," and that "although the arguing from Experiments and Observations by Induction be no Demonstration of general conclusions; yet it is the best way of arguing which the Nature of Things admits of. . . ."[15]

To Voltaire it must have seemed that Newton – so serenely confident, so indifferent to this scandalous state of affairs – was a useful corrective to Locke and the implied threat of a sterilizing skepticism. Newton's dramatic demonstration of the power of the new science – its success in ordering our knowledge of the physical world; its striking ability to predict the unforeseen – was accompanied by his frank avowal that the entire edifice rested upon probabilities. Here was a superlative illustration of Buffier's pragmatic, common-sense theory; and it convinced Voltaire that philosophical doubt need not paralyze action but in fact was the road to successful action.

I cannot agree with those who have suggested that Voltaire's brief excursion into the physical sciences had little influence on his subsequent thought and writing and that he returned without regret to literary pursuits. Some have thought *Micromégas*, his little science fiction tale, to be his swan song, recording his disillusionment with the sciences.[16] Instead, it seems to me merely another assertion of his basic outlook: another assault on the makers of systems, whose futile answers he contrasts – citing the

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achievements of Huygens, Maupertuis, Leeuwenhoek, Swammerdam and Réaumur – with the success of the tiny humans in scientific observation and measurement.

Voltaire's later work shows in a number of places the impress of his early contact with science; nor did he ever abandon his scientific interests altogether.[17] Allusions to the superiority of the analytical method are frequent in his writings, always with appropriate references to Newton and Locke. And numerous are the reminders that absolute truth is a chimera, that our knowledge can only be probable knowledge, which is all that man in his middling state can aspire to. The true method of thought, in philosophy and human affairs alike, is that which Newton introduced, with such success, in natural science.[18] As Cassirer has summarized it so well, analysis was to Voltaire "the staff which a benevolent nature has placed in the blind man's hands. Equipped with this instrument he can feel his way forward among appearances, discovering their sequences and arrangement; and this is all he needs for his intellectual orientation to life and knowledge."[19]

There was a matter of deep import to Voltaire, which commanded his chief attention for nearly a decade late in life, and on which he brought to bear the ideas we have been discussing. This was his campaign on behalf of those men – Calas, Sirven and the others – who were the victims of religious intolerance and judicial oppression. In the 1760's – aroused to fighting pitch by the juridical murder of Calas – Voltaire turned his attention, with the same single-mindedness he had devoted earlier to science, to the study of French criminal law, with particular reference to the strange rules of evidence employed in capital trials. His grasp of the technical side of the problem has earned him the admiration of historians of French law, Esmein for example.[20]

The logical force of the arguments Voltaire directed against some of the bizarre legal practices of his time stems directly from his views about the certitude of our knowledge. Behind the formalized rules of evidence employed by the judges, strictly codified during the previous century, he discerned the same intellectual arrogance, the same confidence in the power of the human mind to attain absolute truth, that he pilloried in theology and philosophy.

"There is no year," he wrote in this period, "when some provincial judges do not condemn to a frightful death some innocent father of a family; and that peacefully, gaily even, as one slits

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the throat of a turkey in the farm-yard."[21] The judges, he remarked, do not suffer from doubts or misgivings and think that guilt can be proved like a theorem in geometry. But can we attain in human affairs such a certitude as will allow "seven men to enjoy legally the amusement of putting an eighth man to death in public?"[22] Voltaire is convinced that we cannot.

"I am certain," Voltaire says in the *Philosophical Dictionary*, "I have friends; my fortune is secure; . . . my lover will be faithful; these are phrases which any man with some experience in life strikes from his lexicon."

The history of the human mind throws a revealing light on this problem of certitude. Before Copernicus, everyone was *certain* that the earth was at rest and that the sun rose and set. Not long ago witchcraft, divination, possession by devils, were the things deemed most certain in the eyes of all men. Yet today this certitude has, to say the least, somewhat diminished. Indeed there is no certitude so long as it is physically or morally possible that things might be otherwise.

Yet many judicial cases, he continues in the same vein, have been settled as certainties when on further examination they have turned out to be errors. "When the judges condemned Langlade, Lebrun Calas, Sirven . . . and so many others, all later shown to be innocent, they were certain, or should have been, that all these unfortunate men were guilty; and yet they were wrong. . . . If such is the misfortune of humanity that one must be content with extreme probabilities, one should at least take into consideration the age, social position, the bearing of the accused, the motive he might have had to commit the crime."[23]

Against the quasi-mechanical system of proof used in the criminal courts – where two half-proofs, as they were called, or four quarter-proofs, added together were deemed to constitute full proof – Voltaire had nothing but scorn. The whole system appeared archaic, fallacious and cruel, especially so in the case of capital offenses. When life is at stake, he insisted, even the greatest probability ought not to be thought sufficient for conviction.

It is perhaps Voltaire's least-known contribution that he sought to introduce this principle of uncertainty into the rules of criminal evidence; and that in pamphlet after pamphlet during this legal debate he reiterated his conviction that in the realm of human affairs probabilities and not certainties are the most we can expect. His

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mature opinion is to be found temperately and gravely stated in a little-read but important piece, his *Essay on Probabilities applied to the Law* (1772). Here, after insisting upon his main point, he writes:

> One must take a stand, but one should not take it at random. It is therefore necessary to our weak and blind human nature, always subject to error, to study probability with as much care as we learn arithmetic and geometry. To judges, this study is peculiarly important. . . . A judge passes his life in weighing probabilities against each other, in calculating them, in evaluating their force.[24]

I have not introduced this topic to suggest that Voltaire is a forgotten pioneer in probability theory, for I am not sure how much he knew of this very important current in eighteenth-century science. I doubt whether he bothered his head with the mortality tables of Antoine Deparcieux, the first in France to continue the pioneer work of Graunt, Petty and Edmund Halley, though he cites him approvingly on one occasion. And he certainly would have made little headway with the work of James Bernoulli or Abraham Demoivre on the mathematics of probability. Yet it is perhaps no accident that a devoted disciple of Voltaire, the mathematician Condorcet, attempted to apply probability theory to the sort of problems which interested Voltaire – the decisions of courts and legislatures – and urged that statistics and probability might some day form the basis of a reliable science of human affairs.

I have tried to illustrate here, by some concrete examples, what Voltaire may have got from his study of Newton. Paradoxical as it must seem, Voltaire appears – for all his technical limitations and his mathematical ineptitude – to have grasped the implications of Newtonian thought and method better than any other French man of letters of the eighteenth century. From Newtonians and Lockeians of the strict observance – chiefly from Voltaire and Condillac – the much-abused *ideologists* of the Revolutionary period took their start. Yet this tradition, culminating in the *Idéologues*, was buried for a time under an avalanche of materialist systems of moral and social philosophy; this line, which extends from Voltaire and Condillac through Turgot and Condorcet, seems to me to embody the deepest and most persistent elements of the Enlightenment's faith in science. At least, so the eighteenth-century scientists appeared to believe; for it was to this current of the Age of Reason that men like Lavoisier and Laplace, among other scienti-

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fic figures who wished to play their role as renovators of society, appear to have lent their allegiance.

III

It is only fair and proper to introduce an out-and-out materialist, if only in contrast to those more moderate men I have already discussed. My candidate is the Baron d'Holbach, whose powerful *Système de la nature* is frequently referred to and, quite evidently, not often read with attention.

The *Système de la nature* is not a work of science or natural philosophy, or even primarily a work of social theory, but a thundering attack on all supernatural beliefs. Having devoted a decade of his life to assaulting Christianity in a series of books and pamphlets, most of them anonymous, d'Holbach was now in 1770 prepared to take the next step and give to the world his refutation of all deists and theists, Voltaire and Newton included.[25] Somewhat incidental to his main purpose d'Holbach pretended to advance a rigorously secular view of man and society, derived – as he sincerely hoped – from the axioms of materialism and of science. From a set of assertions about the natural world – confident, combative and uncompromising – d'Holbach draws out his view of man and his formula for man's secular redemption. Man is unhappy because he is out of tune with Nature; Nature – *le grand tout* as d'Holbach calls it – consists only of material bodies in motion; and man is not only a part of nature, as Montesquieu would have agreed, but is a purely physical being. Just as belief in a realm of spirits, or even in a single spiritual creator, is illusory, so also is the habitual distinction between *l'homme physique* and *l'homme moral*. *L'homme physique* is man acting according to those laws of cause and effect which our senses can observe; *l'homme moral* is man acting in response to physical causes which our ignorance conceals from us.

In the early chapters d'Holbach sets forth his view of physical nature from which all this is supposedly derived:

> It is to physics and to experience that man must have recourse in all his investigations: he must consult them in matters of religion, ethics, legislation, political government, the sciences and the arts, even in his pleasures and sufferings. Nature acts by simple, uniform and invariable laws which experience enables us to know.[26]

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In view of these words, we should expect d'Holbach to share with Voltaire some knowledge of contemporary physics, or at least of the popularized Newtonian physics of the eighteenth century. Yet the "immortal Newton" is mentioned seldom and then with scarcely veiled impatience. And the physics we are offered would scarcely pass as Newtonian. Newton, to be sure, is praised for having done away with the chimerical causes which had been invoked to explain the motion of the planets, as for example the vortices of Descartes; but d'Holbach is unhappy with Newton and his followers for regarding the cause of gravitation as unexplained or inexplicable. D'Holbach suggests that gravitation may be merely a special case of that propensity toward motion which is a property of all matter, and which depends upon "the inner and outer configuration of the bodies," a view of motion which is as far from Newton as it is from Descartes. Elsewhere, with bland inconsistency, he cites the followers of Newton as identifying attraction and repulsion with sympathies and antipathies, with affinities and *rapports*. But, once again, this is not the language of eighteenth-century physics, any more than is d'Holbach's definition of inertia as "gravitation on self" or his use of Newton's Third Law as an example of *nisus*, the urge of bodies at rest to move.

It can be shown that d'Holbach's physical theory owes a good deal to his earlier experience as a chemist, more indeed than to his knowledge, or lack of knowledge, of physics. Chemistry had in truth been his first love; he was the author of many of the chemical and mineralogical articles that appeared in Diderot's *Encyclopédie;* and like Diderot he was a disciple and close friend of Rouelle, the outstanding chemist of the day. D'Holbach's ideas concerning matter – his pan-energism, if I may call it that – owe a good deal to the long line of chemical philosophers, latter-day followers of Paracelsus, of whom one of the most important is G. E. Stahl, d'Holbach's acknowledged hero and a man whose writings on the phlogiston theory he had been responsible in part for introducing into France.

But there is another current still more evident in d'Holbach's thought: his debt to classical antiquity. This was clearly perceived by the prosecuting attorney who read the indictment that led to the condemnation and public burning of the *Système de la nature*. The author of this nefarious and sacrilegious work is not accused of having misused the results of contemporary science, but of

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having revived and extended the materialistic system of Epicurus and Lucretius.

That d'Holbach was thoroughly steeped in the the Greek and Latin classics is evident from the most cursory inspection of the *Système de la nature*. It is, in fact, upon classical authorities rather than scientific ones that his paganism and materialism are explicitly based; and it is just in the pretentiously scientific preliminaries of his book that the classical references are most evident. Plutarch, Lucretius, Cicero – especially the *De divinatione* and the *De natura deorum* – and above all Seneca, provide the heaviest field pieces. Democritus and Aristoxenes are cited to show that in antiquity the soul was thought of as material. Not merely Lucretius but also Manilius and Pythagoras (the latter courtesy of Ovid) are authorities for the eternity of matter. Lucretius is quoted, as one would expect, on the evils that flow from the fear of death; while Seneca provides him with arguments in defense of suicide and with support for the principle that man is inherently neither good nor evil, as well as with useful quotations on fatalism.

The ancients are even made to share in the glory of modern scientific discoveries and doctrines, much in the spirit of Dutens' recent history.[27] Citing Diogenes Laërtius as his source, d'Holbach asserts that the Newtonian "system of attraction" is very old, having been anticipated by Empedocles in his doctrine of Love and Strife. Again he rather labors the point that Aristotle, long before the "profound Locke," insisted that nothing enters the mind except through the senses. Indeed, he seems to take a special pleasure in claiming that the two most popular philosophic doctrines of his day were of ancient origin.

As much as by any other influence, including that of the Greek materialists, d'Holbach's thought is shaped by the teachings of the Roman followers of the Stoa: Cicero, Seneca and Marcus Aurelius.[28] It is from these men, rather than primarily from Newton or Descartes, that he draws his deep conviction of an inexorable order of physical nature, an order to which man, as a part of nature, must submit:

> Let man cease to look outside of the world in which he lives for beings who will give him a happiness which nature refuses him: let him study nature, learn its laws, contemplate its energy and the immutable way in which it acts. Let him apply his discoveries to his own happiness . . . and submit in silence to those laws from which nothing

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can shield him. Let him agree to remain in ignorance of those causes which for him are enveloped in an impenetrable veil; let him suffer without complaint the decrees of a universal force which cannot turn back or ever depart from the rules which its essence has imposed on it.[29]

If d'Holbach makes his bow to the science of his day, it is both awkward and perfunctory. He genuflects appropriately before the busts of Locke and Newton, mumbles the suitable incantations, and passes on to more important matters, and to the search for more convincing authority. It is as if he contented himself with showing that contemporary findings of science appeared to confirm the insight of the ancients that there is an inexorable order of material nature.

If the method and spirit of Newtonian science meant anything to d'Holbach, it is not apparent, not even in his manner of exposition. While Montesquieu's method is comparative and historical, and whereas other writers, like the physiocrats, affected an abstract, pseudomathematical method of presentation, such as Tocqueville and Taine deplored, d'Holbach's method can best be described as rhetorical, dialectical and hortatory. The style moves in whirlpools and eddies: it is a series of loosely-linked affirmations, challenges, questions and indictments. It is the work of a prosecuting attorney familiar with the forms and devices of Roman forensic. It begins, not really with axioms, but with an accusation; it ends, not with a *quod erat demonstrandum*, but with a summation of the case and a final, impassioned charge to the jury.

IV

Regrettably, I shall end with neither, but only with some tentative suggestions. If my account of these three social thinkers of the eighteenth century has any validity, it may perhaps suggest that historians of the Age of Reason have been rather too sanguine in treating the thinkers of this complex age as though they did indeed possess a 'common understanding of science.' I am not too concerned to stress the point that of these three men only one, Voltaire, seems really to have got the drift of Newton. Newton's name was after all only a symbol or catchword of the age, though one of great evocative power. It can do little harm, when treating the eighteenth century in general terms, to use the Newtonian symbol, as did the men of that century, to stand for the complex framework of science itself.

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But if we have been wrong in making science so exclusively the intellectual force which shaped the eighteenth-century mind (and so in consequence much of our modern thought) our interpretations will have to be radically altered. Perhaps we can no longer lay solely at the door of science all the social nostrums, all the flights of fancy, all the naïve confidence in the power of reason so characteristic of that century. Science may have to share the credit and the responsibility with certain less spectacular forces, and one of these I have hinted at. I referred several times to the deep-rooted classical formation of the French mind of the eighteenth century; and I would have liked to develop more fully, especially in my discussion of d'Holbach, the implications of the 'new paganism': that peculiar movement which has its roots in the open or clandestine writings of the earlier *libertins* and which is so marked a characteristic of the last years of the century.[30] The vision of an age before the advent of Christianity — a golden age of free thought and free inquiry when men were men and not fallen angels — certainly served to express the secular aspirations of the Enlightenment fully as well as the vision of a world of the future, guided and improved by the light of science.

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2. *Oeuvres complètes de Montesquieu*, ed. André Masson (Paris, 1950-55), vol. II, p. 228.
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4. *Oeuvres complètes de Montesquieu*, vol. II, p. 847. "Livres bien écrits en Anglois: le Dr. Bangor, Tillotson, Praats [sic], *Histoire de la Société royale.*" Sprat's work had been translated into French as early as 1670.
5. For Comte, see the *Cours de philosophie positive*, as cited by Cotta, *op. cit.*, pp. 10 and 76. For Durkheim, see his *Montesquieu et Rousseau, précurseurs de la sociologie. Note introductive de Georges Davy* (Paris, 1953), with a translation of Durkheim's Latin thesis of 1892. Roger Caillois, in his useful preface to the *Pléiade* edition of the *Oeuvres complètes* of Montesquieu (Paris, 1947) speaks of the "révolution sociologique" as already heralded by Montesquieu's *Lettres persanes* (Rouen, 1721).

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9. "Conseils à un journaliste," in *Oeuvres* (ed. Louis Moland, Paris, 1885), vol. 22, p. 242. In several places – as in the opening lines of the dedication to the Marquise du Châtelet in the first edition of *Elémens de la philosophie de Neuton* (1738), and in several places in the *Micromégas* – Voltaire made transparent fun of the style and method of Fontenelle.
10. Voltaire's interest in Berkeley is described by Libby, *op. cit.*, pp. 105-6; and see T. E. Jessop, *A Bibliography of George Berkeley* (Oxford and London, 1934), pp. 8-9 and 65. Voltaire mentions having had several conversations with Berkeley during his stay in England.
11. Voltaire, *Lettres philosophiques; édition critique, avec une introduction et un commentaire par Gustave Lanson* (Paris, 1909), vol. I, p. 168.
12. Cf. *Oeuvres*, vol. 14, p. 49. The Jesuit Father Claude Buffier (1661-1737), Locke's first disciple in France, deserves more attention than he has received. Author of numerous works, his most important book is his *Traité des premières vérités et de la source de nos jugements, où l'on examine le sentiment des philosophes de ce temps sur les premières notions des choses* (Paris, 1724).
13. *An Essay Concerning Human Understanding*, ed. Alexander Campbell Frazer (Oxford, 1894), vol. II, pp. 217-18.
14. *Ibid.*, p. 350.
15. *Mathematical Principles of Natural Philosophy;* Andrew Motte's translation, ed. Florian Cajori (Berkeley, Calif., 1934), p. 400; *Opticks* (3rd. ed. revised, London, 1721), p. 380.
16. Ira O. Wade: *Voltaire's Micromégas; A Study in the Fusion of Science, Myth, and Art* (Princeton, 1950), pp. 107-8.
17. At Ferney in the 1760's he carried out some experiments, inspired by the findings of Spallanzani, on regeneration in snails. In 1768 he published his *Singularités de la Nature*, a short collection of pieces in which he

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attacked what he believed to be the irresponsible speculations of naturalists: the animal origin of coral; Buffon's theory of organic molecules; J. Turberville Needham's defense of spontaneous generation; the organic origin of fossils; the historical geology of Burnet, Woodward, Whiston, de Maillet and Buffon. "Dans la physique, comme dans toutes les affaires du monde, commençons par douter . . . . c'est la raison éclairée et soumise qui sait qu'un être chétif ne peut pénétrer l'infini. Un fétu suffit pour nous démontrer nôtre impuissance. Il nous est donné de mesurer, calculer, peser, et faire des expériences. . . ." (*Singularités*, ed. 1768), pp. 3-5.

18. Cf. his letter to s'Gravesande (June 1, 1741): "*Vanitas vanitatum, et metaphysica vanitas!* Nous sommes faits pour compter, mesurer, peser: voilà ce qu'a fait Newton; voilà ce que vous faites avec Musschenbroeck. . . ." (Voltaire, *Oeuvres*, vol. 36, p. 65; cited, with other variations on this theme, by Wade, *op. cit.*, p. 164, note 68).
19. Ernst Cassirer, *The Philosophy of the Enlightment*, trans. Fritz C. A. Koelln and James P. Pettegrove (Princeton, 1951), p. 12.
20. A. Esmein, *Histoire de la procédure criminelle en France* (Paris, 1882), pp. 363-370.
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23. *Ibid.*, "Certain, Certitude," *Oeuvres*, vol. 18, pp. 117-121.
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27. Louis Dutens, *Recherches sur l'origine des découvertes attribuées aux modernes, où l'on démontre que nos plus célèbres philosophes ont puisé la plupart de leurs connoissances dans les ouvrages des anciens* (Paris, 1766).
28. This enthusiasm for the Stoic philosophers was shared by others of d'Holbach's circle. Diderot wrote a *Vie de Sénèque* (1779); his disciple Naigeon published a French translation (by a certain de Lagrange) of the works of Seneca. Diderot, also like d'Holbach a student of chemistry, was in general agreement with d'Holbach's theories of matter. See the *Principes philosophiques sur la matière et le mouvement* (*Oeuvres complètes de Diderot*, ed. Assézat, vol. II, pp. 64-70) which was evidently inspired by d'Holbach's *Système de la nature*, as we gather from Naigeon's introductory remarks.
29. *Système de la nature*, vol. I, p. 2.
30. See, for example, Louis Bertrand, *La fin du classicisme et le retour à l'antique* (Paris, 1897), especially chapter 1, "La renaissance de l'idée païenne." The need for further studies of this sort has been emphasized by Henri Peyre, *L'influence des littératures antiques sur la littérature française moderne — Etat des travaux* (New Haven, 1941).

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Science and the Human Comedy: Voltaire

HARCOURT BROWN

I SHOULD like to approach the question of the interaction of the sciences and the humanities from the point of view of the humanist; indeed, I am not competent to look at it from any other. I find that the humanist is interested chiefly in the individual, the maker of the artifact; that he is less interested in the discovery of codes of conduct and laws of nature, in the solution of impersonal problems or the establishment of sciences of human behavior. I feel that humanists need to interest themselves in man as creator, individual, the conscious voluntary artist, rather than in man as member of groups, natural, social or biological, even psychological. We tend to think that what is specifically human is not reducible to laws; that the humanities therefore concern themselves with what the sciences do not, perhaps cannot, because of their methods and material, undertake. We are apt to conclude, whether we like it or not, that when a law is formulated, the phenomena it pretends to explain either are not explained, or, if they are explained, cease to be interesting and important.

The fine arts are our happy hunting ground; in them every work is an exception to some rule or other, no generalization is any real use after the freshman year, no classification classifies anything but the classifier. We do not predict the future; we are doomed to attempt to record the past, if only we can reach an agreement as to just what happened in it; we are not at all happy about the present, because it is fundamentally untidy and not really capable of being understood.

The chief difficulty, indeed impossibility, found in our study is the problem of establishing adequate generalizations. One of our modern semanticists remarks that " the map does not include all the territory "; and hence we, by definition interesting ourselves in the territory Man, find that none of the generalizations, the maps, are sufficiently general to guide us to all men, or sufficiently particularized to describe just one man in detail. We debate over terms, necessarily sometimes, I suppose, but quite needlessly, wastefully, very

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often. Why should we waste our breath over words like baroque, romantic, renaissance, classic, when the human content of the work of art cries out to be grasped? None of us would really sacrifice our individual experience of Montaigne or Shakespeare or Mozart or Michelangelo to a formula that would allow us to write human history without that surge of dawning comprehension in our hearts.

In this sense the humanities can never be a systematic theoretical study. Our concern is discovery and explanation of the individual in terms of his context in space and time; but this process has failed utterly if it reduces the individual to a point where his particular character is lost, where he becomes indistinguishable from any other person who possesses the same race, milieu, and moment, to use the Tainian co-ordinates. Even when we turn, as we must, to the study of communities and states, cultures and civilizations, we are equally anxious to make every possible distinction, to recognize every qualitative difference. In the humanist's quest, similarities, whether between individual human beings or between cultural patterns, are useful only insofar as they lead to the discovery of differences; these resemblances are never absolute, they are merely means to discourse, and they have a way of disappearing just as soon as one turns from the larger group to examine the individuals in whom a fleeting resemblance has been caught.

All this is designed to suggest that the word humanist, and the study of the humanities, can have a precise meaning which I think it may be in all our interests to preserve. I might summarize by saying that the humanist studies to discover individuality and the exceptional; that he has small belief that norms and laws will simplify his task; that his interest is explicatory rather than generalizing; the individual is the phenomenon, the appearance he must save. In this work, the humanistic sciences and the sciences of man may be tools, though on occasion not very useful ones. They do not have the same objective, and the lack of interest in individual differences is a real obstacle to their use.

Trying to reduce a complex problem – the interaction of the sciences and humanities — to a manageable individual case, I propose, therefore, after some general remarks on the heritage left by seventeenth-century science, to examine, not the culture of the West in general, or even the culture of one nation, but rather the effect of science on part of the thinking of one rather representative man. Voltaire's career touches that of so many other thinkers and so many

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institutions that a study of the scientific component should be a revealing particularization of a general question.

By 1700, western Europe had seen a number of organizations established for the advancement of science, academies and societies of the most varied importance, supported in different ways and offering the most diversified opportunities for scientific work. The aristocratic Linceian Academy, founded in Rome about 1603, had left a model directly for the Cimento of Florence, 1657, and indirectly for the Académie des Sciences, Paris, 1666; from a looser, northern tradition had sprung the Invisible College (London, in the 1640's) and from this the Royal Society, 1661. Between these two types lay a spectrum of others, adapted to different mores, arising in scattered provincial cities, some of them short lived, others, persistently and enthusiastically supported, durable and successful. I would not say that the scientist always needed the academy; rather, the success of a scientific academy is evidence that there has been a core of committed scientists whose work has, in addition to its value as science, evident utility to the community, economically, militarily, or in terms of prestige. In England, the Royal Society offered the scientist publication in the *Philosophical Transactions;* an audience to hear and discuss his findings; a mark – the letters F.R.S. – of his profession, and occasionally medals or other awards of distinction. Elsewhere the academies, usually more selective, offered distinction through the very limitation of elections; in Paris, after 1700, the scientist gained a place to work, instruments and materials, the assistance of younger workers, publication of his papers in the annual *Mémoires,* a library and archives, and honoraria of more or less significance.

By 1700, the publication of scientific works had become a profitable branch of the book trade, with wide international connections. Certain academic publications had become classics: the *Saggi* of the Cimento edited by Lorenzo Magalotti; Sprat's *History of the Royal Society of London;* Newton's *Principia,* Hooke's *Micrographia,* works by Malpighi, Willughby, and John Ray; in Paris, works by Cassini, Picard, and others. Perhaps even more important in the cultural pattern were the serials and periodicals, the *Philosophical Transactions* already mentioned, the *Histoire et mémoires de l'Académie Royale des Sciences,* begun in 1700, and the publishers' ventures, the *Journal des savants* from 1665, the *Acta eruditorum* of Leipzig, countless ephemera begun almost everywhere in Europe, in Italian, French, German, English, Latin, in their brief lives paying

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more or less attention to the new sciences. Collectively, these publications offered a means of establishing contacts with colleagues at a distance, of announcing discoveries, of keeping up with the literature. Some of them actually achieved collective reprinting; Pierre Bayle's *Nouvelles de la république des lettres* became a regularly reprinted section of his *Oeuvres complètes;* the *Journal des savants*, originally a quarto, reappeared in several places in duodecimo reprints as well as in a Latin translation; and these are by no means the only cases.

All this activity in the world of scholarship and science created and represented a new attitude in the reading public. Avid for news, for information concerning the last discovery or theory, the latest expeditions and explorations, the reader of 1700, of the period of Voltaire's youth, has an outlook on the world of ideas and theory very different from any observable in earlier periods. I suggest that this difference is due to the rise of the sciences; that the intelligent reader becomes increasingly aware that, as discovery succeeds discovery, as new theories and techniques follow and displace others, there are changes in outlook and basic thinking which he dare not neglect. Already men are repeating, as they have continued to repeat, that more has been learned about nature in a century, or in fifty years, or in two decades, than in all the preceding ages, or since Aristotle and Euclid.

Although the libraries were full of scientific books and periodicals, it was only very gradually that a synthesis was reached, and then not by any means in all areas of thought. We can see scientific patterns spreading in such a title as William Petty's *Political Arithmetic* and later in the adoption of the term *political science*. The Abbé de Saint Pierre, author of the celebrated *Projet de paix perpétuelle*, owed much of his empirical approach to social problems to his years of close association with Fontenelle and the mathematician Varignon in Paris in the 1680's. While Giambattista Vico is not sympathetic to the physical sciences, he reflects a mode in the title of his effort to renew historical studies in his book *La Scienza nuova.* And even the frivolous appearance of Montesquieu's *Lettres persanes* barely suffices to conceal a curious interest in the comparing of civilizations and cultures and moral codes, developed in the belief that rational analysis, scientific analysis, of human behavior would lead to valid and useful results. The climax of the movement is suggested by Maupertuis' *Essai de philosophie morale*, in which a calculus of pleasure and pain is worked out as a basis for the understanding of moral decisions.

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These titles are typical; they speak of an age in which a relatively simple mathematics in combination with a rather naïve mechanistic view of causality seemed to offer a series of basic behavioral patterns which might be found repeated in every sphere of life.

Yet the Europe of the first decades of the eighteenth century was no simple structure. An overwhelming diversity of governmental systems, republics of varying forms, monarchies elected and hereditary, limited and unlimited in every degree, principalities and federations, free cities and theocratic states, lay everywhere to confound the political theorist. This patchwork was balanced by an equally complicated medley of cultures; taste and tradition took no single form of expression, and the level of sophistication of an advanced capital, Paris or Versailles, London or Amsterdam or Venice, offered no index of the intellectual level of the market town twenty miles away. Rationalizing tendencies of thought did not yet affect the laws in force, the weights and measures, the trade and tax practices, all of which would demand a revolution on a continental scale before they could be reduced, not to uniformity, but to reasonable consistency.

If there was a synthesis anywhere, it must surely be sought in the mind of thinkers; there was no trace of it anywhere in practice. Toward the end of his life, Voltaire wrote a tale, *La princesse de Babylone*, in which he used once more the favorite eighteenth-century pattern of the intelligent and curious traveler, this time a pair of lovers, Amazan the Gangaride and Formosante the Princess, who pursue one another in a vast *chassé-croisé* across Europe and Asia; as they go a chapter is devoted to each country they visit, and the impression is finally conveyed that there is no unity or uniformity, no coherence or understanding in all this diversity of cultures, that the only order that can be found must surely lie in the tolerant outlook and liberal intelligence of the enlightened observer.

This discovery, that liberty lies in the mind and cannot be found in the natural order or in institutions, is perhaps the chief legacy of seventeenth-century science outside of its own proper area of discovery and method. Voltaire's heroes, from the Sirian giant Micromégas, sired by Jonathan Swift on Maupertuis' version of Newtonian cosmology, by way of Zadig and Babouc, Candide and the Huron, to Amazan and the Princess, all illustrate this same trait: an alert mind, free from prejudice and systems, quick in sensiblity, provided with common sense and modern mathematics, seeking constantly to

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organize knowledge and promote understanding. They are as remote from the protagonists of Molière's comedies as they are from the conventional heroes of old romances or the Byronic rebel; their life is the intellectual life of understanding, not a quest for power. They ask little beyond a quiet opportunity for a useful existence, the increase of knowledge, preferably in company with a compatible female if such can be found. Philosophically, they are projections of the life Voltaire would lead at Ferney. The final pages of *Candide* show us, not the life he was allowed to lead by the press of circumstance, but rather the sublimed and rarefied ideal, the life of reason on a fertile farm, with company to share the labor and the satisfactions.

These tales cannot be explained in terms of sensibility or literary form alone. Their heroes are not, like other figments, a product of literary tradition and aesthetic response to a matrix of social conditions and public taste. They recall Gordon Craig's preference for marionettes over actors because marionettes do not corrupt ideas with personality. Voltaire used the term *conte philosophique* to describe his stories; the term has largely come to describe his tales and his alone. I suggest that the word *philosophique* is operational here; in its usage it referred to the natural sciences, and I propose that these sciences offer us the clue to these stories.

Voltaire devoted himself to physical science and mathematics from about 1732 until about 1738 or 1739. During these years he performed experiments at Cirey with Mme du Châtelet; he was in constant and friendly relations with Maupertuis, and he read not only Isaac Newton, but also many others, including Pemberton and Clarke. He was acquainted with Algarotti, with La Condamine, and followed the debate over the shape of the earth, just then coming to a conclusion with the expeditions to Ecuador and Lapland. He looked at the sciences as a man who was committed to a point of view on religion and philosophy; he had rejected final causes, in history as well as in nature, and I think he hoped to grasp through the study of physics a method which would lend itself to the analysis of the behavior of human beings in history. He was well aware of the role of hazard in human affairs; what he needed at this point in his development was a method that would permit him to reckon with the actions and reactions visible as he looked at men and their destinies. He was sure that there was a danger in assuming a providential inspiration for actions that could be explained by traits of character and environment, by the pressures of politics, by social and economic conditions,

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by impulses deriving from religious interests or even from philosophic speculation.

His analysis of the historical sequence can be summed up neatly in his epigrammatic antithesis of *esprit* and *moeurs*. *Moeurs* of course is the Latin *mores*, the traditional, conservative, stabilizing element in society; *esprit*, *spiritus*, is the intelligence – critical, creative, inventive, constantly in conflict with the *moeurs*. Together, the two words compose the title of his most extensive historical effort: the *Essai sur les moeurs et l'esprit des nations*, which is a general account of some two thousand years of world history, not, by the way, limited to western civilization. I would not suggest that Voltaire was the victim of what he and his contemporaries would call a system; he would avoid that like the plague. I do suggest, however, that he describes events as the product of two forces, related much as momentum and gravitational pull are in a trajectory, and that he traces the course of events in terms of the customary parallelogram. It is a method of analysis; it does not obtrude as one reads his various historical works. Rather it offers him a means of discovering what is new and what is old in each occurrence, new aspects of movements and trends, and thus introducing an element of measurable cause where nothing very satisfactory had been possible before. History, the most complex of all the disciplines, including as Voltaire sees it not only politics and wars, but also the history of the arts and sciences, of manners and customs, becomes intelligible only as recognizable and measurable patterns can be found in it. As I see it, mechanics offered Voltaire the model explanation.

In this light, the philosophical tales illustrate the method quite as well as the histories. The pattern of events, the chain of causes and effects, the sequence of action and reaction, presented in a background of happenings well known to all his readers, interest Voltaire rather more than the development of character and the creation of emotional catharsis. Motives, sentiments, intellectual attitudes, are all precisely indicated, even when the behavior and dialogue are most comical and witty. Each story becomes a little problem in dynamics; a group of objects in unstable equilibrium is given a little push, the oscillations are recorded, the newly revealed tensions account for the final pattern when all has come to rest. *Candide* is full of a lively indignation at man's inhumanity, even in the throes of suffering from something as impersonal as an earthquake, but it is clarified by the reading of chapters from the *Précis du siècle de Louis XV*. Voltaire

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extracts the significance of a factual account of his own times by marshalling a series of typical situations in a skilfully planned narrative, in which his respect for human ingenuity, for the trades and skills which are a mark of man's dignity as they are the source of most of his science, is made very clear. The ideal is the garden to be cultivated, natural realities to be directed with intelligence and taste, in a growing understanding of nature's laws. At the end, the conflicting motions come to rest, and the momentum of life itself dominates every action.

Among the contributions of seventeenth-century science to the culture of the eighteenth century, none is more evident than the emphasis on the role of experience, the importance of the raw material of life, which must be recorded and carefully analyzed by the use of tested methods. The creative writer took an outlook and a method from those who had something new to say; to a subject matter of contemporary significance he added a spirit that was empirical, somewhat disillusioned, perhaps even pessimistic. He did not at once forsake the aristocratic, historically humanistic, poetic tradition; Voltaire continued to write tragedies in alexandrine couplets to the last year of his life. But the new outlook was vigorous, it contaminated the older forms, which were less and less classical in content as the years went by; and at the very end of the *ancien régime* the best French poet of the age, Greek by race and Greek by training, André Chénier, wrote, in his poem on *Invention*,

Sur des pensers nouveaux, faisons des vers antiques!

* * * * * *

The seventeenth-century scientific revolution produced an intellectual attitude rather than anything so comprehensive as a culture. It had not reached any very large proportion of the educated public in its own era; the noise the scientists have made in history has sometimes been a little out of proportion to their numbers. In the eighteenth century it affected some people deeply, among them Voltaire, Montesquieu and Diderot in France; there is no need to catalogue them elsewhere. Others it left unaffected; most of the dramatists, many novelists, most poets, were untouched by it. The effect on morals, on social relations, on the law, seems to have been delayed by the inertia always perceptible in those areas of experience except in revolutionary times. Voltaire as a creative writer, not as a critic of literature, thus marks a stage in the separation of the loyalty of the

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man of letters from the humanistic culture that supports him. The posing of new issues by science led him to add new dimensions to the skeptical tradition to which he naturally belonged as a French moralist, and thus we have, after about 1740, a tendency to bring the creative writer into fruitful acceptance of the new scientific lines of advance. Why does this occur so late?

Answers to questions of this sort must be tentative. I suggest that there had been no persuasive synthesis before Newton's; that the Cartesian and Gassendist philosophies had made no appeal to the imagination and common sense of writers or readers. The vortices or *tourbillons* of Descartes were simply comical to Molière, and I suggest that they sounded like nonsense to most sensible men, in spite of the number of learned gentlemen who discussed them. The atoms of Gassendi were not new, but they were beyond perception and always had been, and being driven and not active they had no possible use in an imaginative scheme of things, where the human illusion of free will is essential. On the other hand, it was apparent that astronomical observations in the hands of a Newton opened the universe to speculation on a human basis; the law that brought the apple down held the planets in their courses and determined the shape of Saturn's ring; and the light that crisscrossed infinite space was the light dispersed on the darkroom wall. The fact that all these outlets for a dormant imagination hung on simple but new mathematical laws was of the utmost importance in the minds of those who were open to a fresh outlook. From this revolution came in the long run a new analysis of history on a world-wide scale, extending over a period vastly longer than the six thousand years of Archbishop Ussher; a whole range of new ideas on the history of the earth and the origin of the solar system; and the destruction of the barrier that had held mortal man earthbound in spirit as well as in body. So many old explanations long taken for fact were now destroyed; so many ancient symbols of permanence now became fugitive appearances. But let me repeat: all this came not at once, nor for everyone; for many men of the eighteenth century, it was as if Newton had not lived.

A humanist would probably add that the worth of a novel, by Voltaire or by any other writer, does not spring from the fact that the novel is coherent with the Newtonian world scheme or embodies the scientific outlook, but depends rather on organic qualities largely independent of philosophical assumptions. One does not have to have a conscious world view in order to create character; the inter-

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play of personalities, the discovery of comedy or even tragedy in daily life, result from intuitive and usually unscientific observation. The eighteenth century managed to produce literature of some permanent value without a basis in scientific psychology; it learned how to go beyond the type psychology of conventional comedy by seeking out the features of class and status, by studying the influence of trades and professions.

But in all this there is still something lacking, something which an expanding science can contribute. Voltaire's view of man, in history, in fiction, or biography, hardly succeeds in organizing the life of the individual on a rational basis of drives and impulses; the pathmaking work of the introspective Rousseau was not yet woven into the fabric of the time. The creation of characters whose lives are so many evolving sequences of states and outlooks, each depending on the complex of preceding experience, merging imperceptibly into its successor, has to wait for the development of a whole new area of experience in a form available to author, publisher, critic, and reading public alike. We still need a comprehensive study of the debt of the Romantic novelists and historians, the contemporaries of Balzac and Stendhal and Guizot, as well as of the critics, Sainte-Beuve and even Taine, to the various branches of biology developed in the Jardin des Plantes and elsewhere, to the associationist and other schools of psychology, and to the great teachers in the medical schools.

In the eighteenth century, furthermore, the physical world is not a habitat for natural human beings viewed biologically; it remains a stage on which rudimentary organisms work out a human comedy. Nature is a décor which has small value beyond that of pointing up the drama. The development of a literature in which there will be a really interesting relationship between man and his world has to wait for other sciences than physics and astronomy; for geology, for a more complete geography, for the understanding of climate and the biosphere that Humboldt will bring, for a real synthesis of the studies of man in nature. The science of the early eighteenth century could not contribute here, because it had not faced problems on this scale; it could not yet offer the creative writer, the historian, the dramatist, the novelist, and the poet, the method and criteria he would need. Valid and useful as it may have been, the synthesis which the eighteenth century reached in what it called " natural philosophy " was in many ways far from complete. I submit that we are much better off in most respects today.

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The Seventeenth-Century Legacy: Our Mirror of Being

GIORGIO DE SANTILLANA

BECAUSE it assumes itself to be concerned with the essential aspects of Being, seventeenth-century science continues the line of thought leading back to antiquity. It goes on being ontological.

The aspect of Being that it has discovered is matter-in-motion. It transmits this concern to its successors; thus we have eighteenth-century materialism. When d'Alembert suggests that natural laws, if they are really necessary truths, "should be deduced from the very existence of matter," he is epitomizing the scientific mind of the period.

But the seventeenth-century mind is more complicated than that, as some brief reminder of that era may serve to show.

There is a current and facile misapprehension which makes thought move only with science into natural law and determinism. This, of course, is not so. Any rational thought assumes regularity, and the Renaissance had stressed natural law all too much: it was the Stoic version of natural law, the universal cosmic structure acting on each part through astrological and other influences. Even the schemes of such a free, critical and historical mind as Bodin's were greatly overdetermined.

We might say, in fact, that the Renaissance world as a whole was overdetermined. Instead of one simple cause, each event had a great number, coming from all quarters of the cosmos, at all levels, but conspiring and convergent. It takes no less than that to have a cosmology based on forms, and significant forms. It takes no less than the whole of the cosmos to bring forth its image in the microcosm called man.

Overdeterminism may sound like a dreadful constraint, but it is not. It is instead a help to humanistic and poetic feeling, as we can see in John Donne or Thomas Browne. The more richly a substance is determined or 'signed' by the cosmos, the more spontaneously it can act according to its own nature; this is what makes the so complex World of Being a free republic of active entities.

Less than justice has been done, in the current history of science,

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to the enormous role played by Stoicism in the intellectual transition. By transcribing the traditional scheme into properties of strictly determined matter (weirdly conceived, infinitely varied matter, but matter none the less), the Stoic theory acts as a kind of Trojan horse which establishes inside the consensus of public opinion the plausibility of the materialistic view. It presents a common-sense, animistic matter which requires no effort of abstraction and can perform all the things that we expect of life; comfortably empirical matter which encourages experimentation and lends itself to unlimited and inconclusive chemical research; matter which carries with it in the form of 'elixirs' and 'quintessences' all the old 'signatures' of Being.

By contrast, Galileo's endeavor gains a metaphysical superiority which is readily grasped by the better minds. Here is not ordinary 'materialism,' even if Democritus is lurking behind it: here is insistence on the primary, namely mathematical, properties of matter. The cosmic determinism it suggests is brought down to one dominant plane, that of mathematics, and one type of cause becomes sufficient, because it is mathematical necessity itself.

That new cause, then, is far from being simply matter: it is mathematized substance, something which will be able to dissolve into the field theory of central forces. Thus, we have a really new bearer for the cosmological structure – it is a mathematical being, and the signature of things is mathematical.

This is where Galileo and Kepler can meet – in the implied foundation of mathematical rationalism. When Kepler invokes the authority of Proclus, the master of Neoplatonic systematics, concerning the eminent dignity of numbers and of the spheres, it is not simply a devout misunderstanding. If Kepler and Proclus had met, and Proclus had been sufficiently intelligent, it is certain that Kepler could have forced Proclus to accept ellipses instead of circles in his mystical system; these two men were operating from a common base. Proclus would have been more resistant to Galileo, and yet it was Galileo who stuck desperately and unreasonably to the circles of Proclus; he acted as his representative where one would least expect it. He was possessed with what Koyré has called *la hantise de la circularité*.

In sum, these men were still operating within the Neoplatonic orbit. They simply defined more clearly the behavior of Being

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at the level which concerned them, which was the mathematical level. This goes all the way up to Leibniz. Their theory of cognition was also the same – namely, as Spinoza would say, the order and connection of ideas is the order and connection of things. Nature and the mind were one and the same in their order.

If the order of Nature at some point did not appear to conform to the order of the intellect, it was felt to be a tragedy. Thus Kepler searches feverishly for the architectonic principles or 'archetypal laws' above the straight numeric ones. *Which* is their musical consonance and the harmony of their distances? We know how Kepler worked himself to exhaustion over the orbit of Mars – because it would not fit. He tells the story of his predecessor, Rheticus, and of his fruitless efforts to bring the orbit of Mars to order inside the Copernican system. The despair of Rheticus was such that he had finally recourse to black magic and, like Faust, called upon the evil spirit to help him. The spirit came, Kepler tells us, but instead of providing a subtle answer he grabbed Rheticus by the hair, banged his head against the ceiling, then slammed it down on the floor and departed, saying, "That is all you need to know about the orbit of Mars."

If Rheticus had asked, say, about the hidden properties of some stone or plant, the devil would have obliged. But the circles of heaven are holy; the very mention of them drives the devil to madness.

There is not only in Kepler's story, but in Kepler himself, the Faustian tension of the late Renaissance; there is, even in this most guileless of writers, much of the artiness and extravagance of mannerism. Critics of style who are impressed by the new classical poise of the baroque tend to obscure the continuity of the seventeenth century with the peculiar hyperbolic madness of the declining sixteenth. It is probably from it that the "century of genius," as Whitehead called the seventeenth, develops a certain masquelike exaggeration of mood and experience which is more than an exterior fashion. People came to feel this way; those were the days of unbridled emotions, extremes of all kinds, cynicism, cruelty, sensibility, a Spanish-style grandness in all things, and not least in metaphysics.

Both society and theoretical thought enjoyed reflecting themselves, as it were, in the godlike splendor and arbitrariness of absolute monarchy; they were discovering the wonders of centralized power,

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fully explicated. They accepted subjection with a will, and took its harshness not only as a matter of course, but even as a true expression of a certain side of man's nature. We could barely guess the depths of Jansenist renunciation before the recent discovery of that somber figure, Michel de Barcos.

What remains in our memory of the prose of Bossuet, or Donne, are awestruck phrases: "Dieu seul est grand, Messieurs . . . How desperate a state art thou in . . . There is not a minute left to do it. Not a minute's sand . . . For in the wombe are we taught cruelty, by being fed with blood, and may be damned, though we be never borne. . . ."

It has been said that the reign of Louis XIV, beneath its trappings of sunlike splendor, signifies the advent to power of the bourgeoisie. True. But it is only of the bourgeoisie as a new sternness and organization at the service of the sovereign will. Colbert and Boileau are two complementary aspects of it. Harshness is the common experience. It takes the practical soul of Hakluyt to be shocked by the waste of manpower which is implied in the hanging of poor people for trifling offenses, "even twenty at a clap out of one gaol." No one heeded him at the time. At the very court of Louis XIV, where the king gravely took off his hat to the servant women, Lauzun could consider it a good practical joke at a garden party to grind under his heel the hand of the Princess of Monaco, resting on the grass. Conspicuous hangings at Tyburn and the execution of La Brinvilliers were social events like today's heavyweight title bouts.

The mechanical grottoes complete with mechanical nymphs and hobgoblins built into the landscaping of Versailles and Vaux-le-Vicomte are not the *rocaille* rococo amusement they will be in the next century; nor are they a merely literary reminder of Homer's cave of the nymphs, any more than Molière's Alceste or Tartuffe are mere characters of comedy; they really exorcise an ancient set of subterranean horrors, as we may realize in reading La Mothe le Vayer's allegory on that famous cave in his *Hexaméron rustique*. In the same vein, the *Mundus subterraneus* of good Fr. Kircher is already a serious contribution to geology, but it still refers to those regions as *abscondita Naturae sacramenta*. The years 1650 and 1681 are all-time highs for astrological literature in England, closely followed by France and Germany. In those years five times as many astrological titles are published as in any other year, and this has to do with comets and end-of-the-world computations.

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Such random features compose in our memory into an image far from all happy mediums. Galileo's sentencing is a spectacular production worthy of being portrayed by Veronese: it wilfully brings out by contrast the utter senselessness of the whole story. Spinoza's unworldly calmness may seem to be at the other pole; still it is no less extreme in its implications than the goings-on in *Arden of Feversham*. The heroes of Marlowe, of Corneille or Lope de Vega think and live in extremes. So does Kepler. And under his studied evenness of demeanor, "that Grand Secretary of Nature, the miraculous Des-Cartes," is no less hyperbolic in his affirmations than he was initially in his doubt.

Small wonder that this should have been the epoch of metaphysics in the grand manner, just as it was of the drama. The fantastic arrogance of the mind inventing the ultimate logical design of the cosmos or the rigorous theodicy was strangely coupled with a Jansenist or Presbyterian somberness in submission. Disagreement, too, in the grand manner, grandiose conflict resolved, the skies revealed, were part of the scheme – but it were better to let Sir Thomas Browne say it in his own way: "The mighty exantlation of truth, wherein, against the tenacity of prescription and prejudice, this century now prevaileth."

The scene changes completely with Newton and Locke. We all know it, we feel it. A new spirit has entered science. I should like to try to identify some of the fundamental differences.

If we look back from that position, we are able to see how much the seventeenth century, in its dramatic discords, has given to all of its thinkers in common – to Galileo, Descartes, Spinoza and Leibniz as well as to their traditional opponents. And I would say it is not only a unity of style; it is a common Greek framework to their substantialist point of view – what is technically called the *analogia entis*.

Technically, the Aristotelian Analogy of Being is not such a simple idea. In sketchy outline, it says that all intelligible discrete parts of reality are one only in reference to the finite whole which contains them. Unity and individuation presuppose the cosmos.

But I am going to use the Analogy of Being here only in its intuitive sense: the being called Man has naturally in him the ability to grasp the nature, the oneness of other beings, even as his own.

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Thought naturally grasps nature – for there is in the Greek word *noein* the idea of grasping – insofar as it is itself part of *natura naturans*. Hence it can provide a science which is truly a Mirror of Being, a *speculum entis*.

When Galileo in his *Dialogue* has to confront Dr. Simplicio, the obdurate Aristotelian, the amount of intellectual exchange that makes it a true dialogue comes from the area of agreement between the two. They start from what is for both incontrovertible, namely, that the universe is a whole, finite and perfect, indeed the most perfect work of art. And when Simplicio refuses the new mathematical mode of thought, Galileo can well remind him that its cognitive foundation is the same. The famous parallel that he establishes at the end of the First Day between the human and the divine mind is a transposition in a new key of Aristotle's twelfth book of *Metaphysics:* there is knowledge only because of the fundamental identity between *nous* and *noeton*, between the knower and the known, or, as Parmenides had said, "Thought and the object of thought are one and the same."

Galileo, like Aristotle, like Spinoza himself, would say that our mind is *quodammodo,* in a way, but securely, at home in the divine mind, if it will only lift itself to total rationality. He only wants to specify that the "mode" is that of the primary qualities of matter. In each man the whole of truth is present, potentially; in Simplicio, too, and that is why he can be compelled socratically to discover what he knew already.

That is also why Galileo's conception of experiment is so little empirical; in contrast with the raucous appeal of the Aristotelian to facts and to common experience, he resorts to the thought-experiment. He uses facts only as a check, as a discriminator between necessary and wishful arrangement. But the arrangement comes first, as witness his unfortunate passion for circles: the concrete is explained by way of the abstract, what *is* by what *is not*.

The dialogue is truly alive because Galileo is forcing Simplicio to remember how much of a Platonist he, too, really is. And, however much the substance has been changed which is the carrier of reality, that substance still carries also with it the *analogia entis*. It is still, and quite properly, overdetermined. That other new departure, the biological theories on preformation, on the Chinese-box *emboîtement des germes*, expresses a preposterous faith in a once-for-all overdetermination. One has to attempt either some such

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notion or a geometrical arrangement superimposed on it, or, when this too has to yield, a metaphysical rule emerges which is conceived as replacing the order of forms, viz. the Principle of Least Action. A principle of economy acting on maxima and minima is not as beautiful as a formal geometric principle, but it is just as teleological, and it is a more flexible and powerful abstraction; we know all that Leibniz was able to achieve with it. Even with a fully formed mechanics, Euler sees strictly in this light the differential equations he has discovered for the motion of a particle:

> There must be a double method for solving mechanical problems: one is the direct method founded on the laws of equilibrium or of motion; but the other one is by knowing which formula must provide a maximum or a minimum. The former way proceeds by efficient causes: both ways lead to the same solution, and it is such a harmony which convinces us of the truth of the solution, even if each method has to be separately founded on indubitable principles. But it is often very difficult to discover the formula which must be a maximum or minimum, and by which the quantity of action is represented.

This 'harmony' it is which allows the new substance, matter-in-motion, still inadequately conceived, to overcome the miseries of simple location and misplaced concreteness, and to be transmuted eventually into that most sophisticated of substances, the Leibnizian monad.

Leibniz is very clear about it. Substance is what he needs. It remains substance even outside of the Aristotelian scheme: something (a *vis*) which is capable of being both active subject and passive object. As he will say most revealingly, "What I mean by substance can best be grasped by way of that substance called 'I.'" With that, the *analogia entis* is narrowed to a fine point. Substantial Being is the locus where freedom meets necessity.

Galileo's original single substance is, however, full of contradictions. On the one hand, its link with pure geometrical forms ties Galileo's thought still to the finite, and we see his obstinate resistance to the other half of his mind, which pushes on toward infinity.

Finiteness is reinforced by the appearance of that new instrument of explanation called the model. No longer is the universe mirrored in every part of itself: a section of the universe can be repeated on an arbitrary scale by means of the mechanical model. It is difficult to imagine a model not founded on the stabler and simpler qualities.

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There can be no model for a section of Aristotelian or Stoic or even Leibnizian nature except nature herself.

But on the other hand, if Copernicanism means anything, it means the 'breaking of the Circle,' it means infinity. The founders of science skirt the issue as best they can; it is left to another kind of mind to realize the consequences – I mean the full metaphysical and poetic implications. This happens with Giordano Bruno. At his death in 1600, Bruno has already gone the whole way.

The discovery of Copernicus – the 'fact' – is in Bruno only the detonator of his Neoplatonic-Pythagorean mixture. Although no mathematician, he has realized the new metaphysical idea that mathematics has brought about – namely, that Being in this key (we might call it Pythagorean Being) cannot be kept down to finite size.

The device that Aristotle had found for insuring a finite world was to make one part of Being perpetually a state of potency, and the other part a state of finite actualization. That device becomes unacceptable, for what is mathematical is always "all there," wholly actualized. Hence new solutions for the rhythm of becoming and the growth of the living form have to be found. Totally actualized being can only be expressed in its invariant forms, its laws will be of the type supplied by transformation groups. That, however, is far in the future; in this time of inception, we cannot expect a clear idea of all that the change implies. Only the requirements are passionately felt.

To a mind like Bruno's, filled with Neoplatonic speculations, the change from Ptolemy to Copernicus is a theological one. God has become immanent in the universe instead of being transcendent to it, for the universe is now as infinite as God himself is. For Bruno, it appears as a logical consummation: "it is not fitting" that God, who has always been conceived as totally actualized in himself, should not inhabit a world totally actualized too. The ancient idea of the *theoprepēs*, of what befits the Deity, comes back with explosive force:

> . . . . I do not demand infinite space, nor does nature have infinite space, for the dignity of corporeal dimension and mass, but for the dignity of corporeal natures and species. For the infinite excellence manifests itself incomparably better in innumerable individuals, than in those which are numberable and finite. Therefore, it is necessary that of an inaccessible divine countenance there be an infinite image, in which innumerable worlds, such as the others above us, exist as infinite mem-

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bers. So in view of the innumerable grades which must represent the unfolding of the divine incorporeal excellence in a corporeal way, there must be innumerable individuals, and namely these great animate beings, of which the earth is one, our Divine Mother who has borne us and nourished us and at last will take us into her bosom. . . . I believe there is no one to persevere obstinately in the false denial that as for space it can infinitely contain, and as for the individual and collective excellence of infinite worlds that they can be contained, any less than this world which we know. Each of them has a reason for appropriate existence. For infinite space has infinite aptitude, and that infinite aptitude attains its glory in an infinite act of existence, whereby the infinite efficient is saved from being deficient, and the aptitude from being fruitless.

We see where the idea can lead of Being as a positive good, or, in classical terms, as a 'perfection'—an idea which our present consciousness can approach only with misgivings. Kepler is not unaware of these implications, but, like Copernicus, like Galileo himself, he backs out. The need for a finite universe, well and warmly contained within its outer glacial limits, is stronger in him than his own adventurous imagination. Fifty years later, Pascal puts it with his usual frankness: "It will be a good idea," he writes in fragment 218, "not to go any deeper into the opinion of Copernicus."

But Bruno goes the whole way. It is in him that the two world views, the old and the new, both vividly present to his mind, come into destructive conflict. On the one hand, he still thinks in terms of forms—after all, a man cannot jump over his own shadow. He feels the need for the finite, for the sake of that restrained actualization of Being that is form, for what it grants to the thinker—the possibility of vision, of the dense intuition, of the growth of thought in contemplation.

On the other hand, that Being is now conceived as expanding beyond all limits, and in this realization the mind is torn from its anchorage, it feels, as it were, propelled into infinity. Thus the outcome is not simply pantheism and serene acceptance. The intensive thought which used to be brought to bear on finite entities, which reflected, as it were, their Being on man, is now brought to bear on what Bruno perceives can be only a continuous process, an analysis without end, a trajectory toward ever-receding horizons, in which man has to surrender the limitations of his own finite individuality. When Bruno was sentenced to the stake in 1600, he must have thought of his own prophetic image: the hunter who

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has come upon the deity in the dark woods, and is torn to pieces by his own staghounds turned against him.

The world of Galileo and Kepler, although strained to the conceptual limit, although dangerously nominalistic, remains congruous to the universe of discourse of Dante. It does raise major problems and terrible questions within that universe; but it cannot and will not answer them, for it insists on remaining, if one may say so, metaphysically isomorph with the classical conception.

With Hobbes and Newton and Locke, we are undeniably in a very different climate of thought. That Hobbes and Locke refuse the *analogia entis* is obvious. We are moving from ideation to ideology. What concerns us here more directly is to see how it happens with Newton.

As a Cartesian, Newton cannot see gravitation as in any way deducible from the essence of matter. That is why he says, in effect, "I don't understand it, *et hypotheses non fingo*." To him gravitation is a miraculous intervention, an act of God whereby the simplest order and dynamic equilibrium are maintained in the universe. In his famous passage on God Newton writes:

> A true, supreme or imaginary dominion makes a true, supreme or imaginary God. And from his true dominion it follows that the true God is a living, intelligent and powerful Being. . . . We know him only by his most wise and excellent contrivances of things, and final causes; . . . but we reverence and adore him on account of his dominion: for we adore him as his servants; and a god without dominion, providence, and final causes, is nothing else but Fate and Nature.

This is truly the nominalistic break. This is the primacy of the Will. God is no longer a mind in which we can "find ourselves at home," as the Greeks might have put it, and as Galileo understood it. God is an impenetrable Will, and all we can do is try to understand his intentions as best we may, in order to carry out those intentions. Newton deals with God as a Grand Vizier would deal with a fearsome Sultan. He has deciphered one of his major decisions in natural philosophy: he tries in other directions too. It is usually considered a blemish on Newton's life that he spent the last twenty years working out numerology from the Scriptures, and became impatient when people asked him questions about physics. Yet we should see the logic of it. Newton was trying to discover the will of God again by way of numbers: this time his will

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concerning man. He did not get anywhere; but the intention is clear.

Yet what Newton has gained is not small. He has imposed the feeling of something radically novel: the discovery, on an unsuspected plane, of laws which rule the stars in their courses, the mystery of heaven at last understood: it is a new combination of intellectual pride and emotional resignation to 'iron determinism.' The notion of a sky henceforth silent to our prayers can fit a detachment in the Spinozian vein, or it can become a kind of Presbyterian surrender to the Law; both are represented in the new high priests of science. Absolute and simple mechanical determinism was, of course, a myth. It would have rationally led to a block universe where nothing happens. But out of the myth of necessity, a new metaphor of Being had established itself. It needed no other religion; it was a religion itself, with its basic religious paradox: a new power of the mind, a new irrelevance of man. Such is the new *speculum entis.*

Once the link between man and nature is broken, we are left fumbling as to the nature of knowledge. We get soundly practical attempts, such as Locke's, which creates the phantom of a power of objects to induce representations in the mind; a common-sense idea which will come to scientific fruition in our time, but one which philosophically is hardly more than nonsense. Epistemology has reared its ugly head. The Principle of Individuation does not know where to look for a new home. The Mirror is dangerously cracked.

Thus we enter the eighteenth century, the *siècle des lumières,* in a situation highly exciting but also very untidy. All sorts of startling propositions offer themselves as seemingly irrefutably empirical and invite the most diverse deductions. The century is strewn with the corpses of such theories. The conflict between Cartesian rationalism and the new empiricism creates an occluded front between the two leading countries which lasts well into the second half of the century.

In the end, a general agreement is established, under the ironical gaze of Hume, on what we might call a new type of *analogia entis.* It is a naïve materialism: man is matter too, of a freewheeling variety. So the analogy proceeds. We remember that d'Alembert still hoped to derive the laws of nature from the "essence of matter."

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In fact, a new mythology of matter is arising, which will break down only in the nineteenth century. Nature, as Fontenelle presents it, is nothing but a stage set and a *trompe-l'oeil.* The real action takes place by tackle and counterweight behind the scene. "'I perceive' said the Marquise, 'Philosophy is become very mechanical.' 'So mechanical,' said I, 'that I fear we shall quickly be asham'd of it. . . . Pray, tell me, Madam, had you not formerly a more sublime idea of the Universe?'"

But the eighteenth century has an extraordinary clarity, all the same. It has the illuministic clarity, the will to light, the hope of a new reason and a new justice. This explains, of course, the social intensity of the scientific campaign – a pragmatistic intensity, surely, which develops a shameless Baconianism, but aimed at awakening a new common sense.

That such a common sense needed the new *analogia entis* goes without saying. The offensive against authority and mystery provides reassurance by way of simplicity, and the ways of matter seem to be so gratifyingly simple. There is nothing simpler than gravitation, asserts Voltaire without batting an eyelash. There is nothing so amusing as electricity, says Priestley, while pigs are roasted electrically and a chain of six hundred obliging monks are made to hold hands and jump in unison through the discharge of a condenser. This is science in action. This is fun.

The class of which Voltaire is the exponent does not serve science, nor does it superstitiously respect science for the sake of applications, as it would today. It uses science for a showdown. It is only in the eighteenth century, not in the seventeenth, that the sentencing of Galileo becomes truly a scandal and a *cause célèbre.*

The very intensity of the dialogue prevents a high philosophical level, but it makes the mediocre level effective. The Jesuit and the freethinker adopt similar references, a similar tone – they court social attention and social frivolity, they aim at entertaining and provoking. This is the obverse side of what we call the interest in science. There is no time in which social motives control so overtly the intellectual superstructure. In the mood of intellectual nostalgia which often overcomes us when we think of that so-desirable era, we say that a junction was effected then between humanistic thought and scientific awareness which has been lost since. The complaint may be justified. But let us consider, first,

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that intellectual life was then restricted to a small elite composed of men who had lively social intercourse with one another, few of whom were specialists in our sense; second, that much of that 'philosophic' elaboration does remain on a painfully amateurish level. Misapprehensions, scientific fantasies and frivolous systems flourish in tropical luxuriance. Fontenelle stands out like a shining light in that confusion. When the matter has to be handled seriously, we are led back to what is not our modern problem only, but had been expressed already by Kepler: "It becomes an increasing problem," he had written as early as 1609, "to write on science today. If the argument is not carried on with the proper rigor, the book is not mathematical. But if the proper rigor is observed, it becomes most difficult to read. . . ."

Thus, what Montesquieu fears as the 'tyranny of geometry' is mostly an unwarranted intrusion of amateur physics in fields where experts would have feared to tread. It is in this light that we ought to read his famous pessimistic remarks of 1717, echoed later by Diderot, on the decline of the mathematical sciences: "Discoveries have become rare, it looks as if there were a kind of exhaustion in observation and in observers. . . ." Clearly, if something still held the dialogue together, it was an aesthetic tension, the irresistible element of style and composition, that all-pervading thing called *le goût*.

These qualifiers, of course, in no way reflect upon the great and real advances of the time, or on the hope, and courage, and honesty of the main enterprise. Nor, certainly, on the will to clarity, and to clarification. Present-day logical empiricism – even much more so than Comte's original positivism – is a direct offspring of the eighteenth century. It is the successor of Hume and Gibbon, it is in the line of Condillac and Lavoisier's search for a 'well-made language.' It is in character, too, unmistakably *dix-huitième*, the conclusion of the light-hearted and reckless charge against pompous oppression and stilted prejudice, in that same spirit which urged Voltaire to spend his best years avenging the wrong done to Calas. Not by chance was our modern movement, the 'Vienna Circle,' born in the last country which carried into the twentieth century the too soon extinguished echo of Mozart and Watteau.

The problem today is this: what is left to overcome? The door has opened with a crash, and we have at times the feeling of spinning dizzily forward without being able to regain our balance.

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For here we notice the second crack in the Mirror of Being. Our century brings right with its beginnings (that is, in 1914) a new degree of arbitrariness in physical thinking which does provide the freedom needed for dealing with quantum phenomena, but at the price of metaphysical consistency, as Einstein has ruefully pointed out. On the literary plane at least, the change might be said to fit the 'era of wonderful nonsense,' as the Twenties were called, and one detects an echo of that era in the intellectual mood of the young revolutionaries of physics. The outcome is a reality which is accepted as theoretically *less* than determined. Both nature and the object of the search are seen as *underdetermined* in themselves, and the observer – or rather his choice of action – comes in to complete the picture. Man has forced his way back and he has been widening his bridgehead ever since. But what kind of man is that? And what kind of free activity?

A complete rejection of metaphysical implications – if it were possible – might give us what used to be called the freedom of indifference. When the hypothesis is guided only by experimental consequences, when we are willing to suppose anything that will 'work,' when nothing is too far-fetched to try, we have surrendered choice of thought, and enter a phase which has some of the aspects of intellectual nihilism.

One need not stay forever the prisoner of Platonic circles. But when the empiricist suggests that science is a set of operational rules for changing marks on paper, he is obviously overdoing it. Science is and remains the search for some kind of being, even an elusive being like a meson, but still a real entity. Stars are real and so are subatomic particles; they are not merely marks on photographic plates. When Leverrier found Neptune "at the tip of his pen," as panegyrics said, he was not simply looking for an economic regularizing entity – he was thinking of a new planet. Fermi knew too much about the neutrino to regard it as a mere accounting device. Entities may become rarefied and still remain such. One may believe even in a vector in Hilbert space, for it is an entity conformable to our search. But supposing demons turned out to be a paying proposition in our scientific explanation, would we use demons in physical theory without further concern? I do not know what the pragmatist would answer, but to be consistent he ought to say "Yes." Infinite freedom to posit anything that pays off is like infinite freedom to move anywhere in a desert.

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The fact is, scientific work does use guides even if they are usually unacknowledged. 'Revision' is a word now frequently used in physical theory. It means changing our conception of what is real in the picture so that it comes to fit what we imply by reality. The unresolved mixture of science and metaphysics that we have had since the seventeenth century gives us directions about things to try. The simple directions which once guided the attack – materialism, absolute determinism or pan-mathematism – are now points beyond the horizon, like the Islands of the Blessed, but they still influence our course.

Let us then not take science for what some of its philosophers would like it to be. Completely 'intersubjective' statements from which all metaphysical shadow is banished, from which any implication or discussion of being is removed, could occur only at the point where there are no subjects left to share them. So long as it is alive and not sterile, science will remain a *speculum entis*, it will present what metaphysics did, a symbolic structure which is an essential metaphor of being, but is not the only one.

Inevitably, if science were to insist on presenting itself as an assemblage of devices for pragmatic power and economy of thought, if it were to disguise its poetic objectivity under technological wizardry, then misunderstandings would be bound to occur. Outsiders will ask whether such a program could not just as well have fitted Renaissance nigromancy, with its system of recipes. It is only too obvious to the perceptive mind that the eighteenth century spirit among us finds little left to combat which has any stature and glory, and that debunking has become a poor game.

There arises then inevitably, too, an estrangement of public feeling; and mounted on it is the counteroffensive of bewildered humanists, which is becoming, in some, a veritable paranoia leading to a most pointless battle with windmills.

Those who believe intransigently in the right of science to lead may find these difficulties irrelevant. It is, they will say, a matter of education and patience, of taking the horse to the trough again and again until he drinks, with no concession to popularizing pressures. The researcher's business is simply to go ahead. But the trouble is right here: that science has been going ahead on its straight and logical way, going fast, and thus leaving behind all the traditional involvements, including its own. The scientist has ceased taking part in the great dialogue as cultural being. The little gusts

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of revolt blowing through society are the kind that the statesman might find worthy of attention.

I would suggest that the instinctive reaction of the social body, of that communal sense which has an obscure wisdom of its own, shows the start of a retreat from science to prepared positions. There is no antiscientific commitment and there cannot be, except in a histrionic vein; but a choice of interests is discernible, a concentration upon a form of knowledge which takes the place held of old by speculative metaphysics, by classic tragedy and generally by what Aristotle would call, with a trace of condescension, "the weighty testimony of the poets."

I am referring to the novel, and of course to the important novel. When even professional philosophers think they have to take that road, it is indeed a significant decision. As a form the novel is hardly more than a century old, and not coincidentally it covers the same span of time as the unscientific philosophies born of Romanticism. Like them, it brings to the consciousness a new perception of life and time and history, it draws from a new communal sense. Like them, it represents a deliberate break with eighteenth century ideas. It is not a *conte philosophique;* it has no thesis.

We should realize the difference from the past. For Galileo or Descartes, who yet were both instinctively artistic natures, history was a repository of classical examples set out in fine style; art and literature were essentially works of high craftsmanship meant for the pleasure of the senses, a display of magnificence and taste. They were, strictly speaking, not 'serious,' in the way philosophy is serious, or proper worship, or the 'great affairs of princes.' To the modern mind, on the other hand, what looks 'serious' is the flash of a true experience glimpsed in the rushing stream of time. It is from there that speculation can take its start.

What the reader searches for in the novel is, I suppose, an increase in his own range of life-experience and understanding. His interest is aesthetic but also speculative. He is having his theoretical moment, the one that science refuses to supply, and he is having it in the ancient and original sense.

On what level? I would suggest this: the novel is built on an experience of reality, but it presupposes an essential order which is beyond experience, which is rediscovered in experience, and

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which provides it with a meaning. Every new narrative is, in a way, a new experimental approach. The narration circumscribes, as it were, the enigma. Its invariants are less abstract than those of science, but it, too, is a search for order in a world initially experienced as chaos. The search for an enigma of order inside chaos is manifest in that weird and sometimes hellish quality of reality which, far from being the privilege of existentialism, strikes us so often in our own time: "History is a nightmare from which I am trying to escape." Translated into abstract terms, it would be quite parallel to the Platonic escape from the physical world by way of its discovered inconsistency.

This is, then, another aspect of the search for truth. It admits reality as 'chance and necessity,' but chance is not considered a principle of reason – or, on the other hand, a camouflage for a pre-established harmony. The attitude remains one of methodic doubt, the search for reason and for a principle of order. We see the artist using the visible forms of convention as a stage set, and insisting on the contrast between those forms and the original nature of 'being' on which they try to impose their rule – the contrast which generates conflict and irony. It is the search for this 'being' which provides meaning and depth. In Maxwell's classic words concerning knowledge, "It is a universal condition of the enjoyable that the mind must believe in the existence of a law and yet have a mystery to move in."

Maxwell, like all true poets, speaks in universal terms and with a measure of ambiguity. But we rediscover in his words the classic *analogia entis*. What makes the mystery "enjoyable" is the intuition of an identity of nature between the law we discern and that of our own being. As he says elsewhere, the scientific mind should be "an abandonment of wilfulness without extinction of will." Now modern science has accepted wilfulness in the pragmatistic conception of itself. However philosophically and even dialectically justified, that wilfulness is subtly present in epistemology, where it has been detected and denounced by Einstein, acting out the role of Tiresias. It is patent in the attitude toward nature, which is one of acosmism, of advance as an unending breakthrough.

The shift, then, in canons of relevance that we discern among perceptive minds outside science, the increased attention and sensitiveness to literary existentialism in its many forms, is not simply a 'reactionary' movement. It is a reaction, surely, of the communal

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sense, but not antiscientific; it is postscientific, in that it discounts in science a philosophic interest that science itself seems to have wilfully devalued. The center of relevance has moved to the range of reality which awaits forever to be metaphysically resolved – to the *condition humaine* as such, to quote a designation used successively by Montaigne, Pascal and Malraux. In that range of reality, we find, beyond all sociology and anthropology, an inviolate resistance of the object, which is man's nature itself, the dramatic experience, the 'mystery in which to move,' i.e., the intuition that the universe and the subject are of the same nature, the possibility of achieving or regaining an insight by means of art.

To that range of cosmic reality there are also other approaches. The 'religious revival' of which there is now so much talk may be mostly of an irrelevant kind, but it has its high points too, and one of them leads us back to Newton with great and meaningful irony.

We remember Newton's own attempt at combining science and the humanities, I mean his previously quoted definition of the God of natural philosophy, which concluded: "We reverence and adore him because of his true dominion. . . ." This kind of God was, of course, a scientific metaphor of being, and a rather unfortunate one, which was disposed of in short order. But the live element of it (we can spot it in Laplacian determinism and ever since) was 'true dominion.'

In our time, we have the case of Simone Weil, herself a member of a distinguished scientific group, a freethinker reared at the *Ecole normale* in the great tradition of seventeenth-century philosophy. It is within that frame that she lived the tragic modern experience. Following her religious illumination, she looked anew at the classical Cartesian metaphor of being, namely inertial matter, and she saw it rightly as a physical myth which inside physical theory had created more difficulties than it solved. By transferring it to the other range of reality which had become her concern, she brought it to life again. It becomes there a metaphor descriptive of social humanity itself, society functioning under its own weight and inertia, *la pesanteur*. It is a determinism which rules behavior, imaginations and desires. It creates the chain of evil and its counterpart, human 'affliction,' blind suffering. Wrong breeds wrong; the normal social virtues of tolerance and compromise are seen merely as lubri-

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cants for the machine. There is a pitiless realism in the way Simone Weil perceives the mechanism of affliction, which excludes from it any redeeming quality. "Affliction is anonymous above all, it makes victims into things." Here, surely, is the dominant idea, and one not unnatural in a progressive century in which already eighty to ninety million people have been killed in the name of various and novel rationales. As physics moves away from rigid mechanistic determinism, which appears now as a myth, as it projects a universe of loosely coupled systems, transient states, and limited predictability, the mechanistic symbolism finds a new habitat; 'thingness' becomes evident not in things but in what men do to other men.

This intellectual vision may be compelling only to a few, but even to those who will not accept it, it will look imaginative and weirdly plausible. Affliction, as Simone Weil understands it, does not lend itself to consciousness, it empties the soul of the afflicted, "who fills it with no matter what paltry comfort he may have set his heart on." It may be scavenging in the garbage of the concentration camp, or it may be a raise in wages and a two-car garage.

Descartes' pure analytical or dissociative relationship in the *res extensa* is here given a fair parallel. The 'wholly other' from this kind of matter, that which corresponds to the *res cogitans,* on this new level, is Grace, which makes the soul come alive. Thus, emerging out of an acceptance of the modern scientific universe, a theological world in the seventeenth-century style comes into being, and one that Malebranche might not have disavowed. But it carries its modern logic very far. It is known that Simone Weil never accepted formal conversion, choosing to identify herself "with the immense and unfortunate mass of unbelievers." She seems to have meant it strictly. The course of modern critical thought on all its levels, which dissolves even the notion of personality, had led her to consider religious symbols as fictions. She insisted that the real religious experience in a world of chance, necessity and automation, of force and affliction, of aspirin and antibiotics, was the absence of God. The silence, the powerlessness, the nothingness of God are the messengers of his true presence.

If God were the power behind this show, she said, taking up the words of Ivan Karamazov, then one would feel compelled to "return the ticket." But if God is not there, then his Grace becomes a reality in us by way of a metaphysical paradox; we enter a kind of gnostic theology of divine non-being.

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There is no mistaking the irony of it over against the Natural Philosopher's theology: "A true, supreme or imaginary dominion makes a true, supreme or imaginary God." The answer now is: "Only a dominion which is less than imaginary, and in fact non-existent, makes the true God."

What I have been trying to do is to read the modern predicament in the light of the requirements set by that boldest of centuries, the seventeenth. What we find is an apparent scattering and alteration of factors over the whole map – in reality a richer, unpremeditated texture. In it the illuministic offensive, the "mighty exantlation of truth," is represented by the advance of science. But as the language of science moves farther away from common sense, as the scientist allows himself to be justified in the public consciousness by pragmatic results and technological wizardry, the search for the Analogy of Being, for the Mirror of Being, has to shift to other levels. Undercommitment in the way of scientific 'truth' brings overcommitment to other forms of truth, until the very idea of commitment becomes starkly problematic. That is where the novel has come into its own. Metaphysics is now woven into the texture of experience itself and confronts man through his life in unexpected ways. The sentient being who finds himself existentially 'thrown' into the situation has to face it and create his own system as he goes along, or be enslaved by another man's, without benefit of high abstraction. Too often, he will put the blame on 'Science.'

Yet, if only science avoided becoming the prisoner of its formalistic refinements or of pragmatistic roughness – if it accepted the Maxwellian definition of itself, it would find its old place in the great dialogue not simply as a structure of symbols, but as a Metaphor of Being. It does not differ in this respect from traditional metaphysics, except that the metaphor is more carefully and consistently worked out through the ordeal of experiment and the labor of generations. Its own dialectic, if deemed worthy of attention, would reveal itself tied to the dialectic of the other forms of thought, and such principles as indeterminacy and complementarity would show a value which transcended their strict operational significance.

The way for humanism to co-exist with science is neither to damn it nor to try to imitate it. Rigor and elaborateness as borrowed from

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science do not fit humanistic disciplines, nor do the more technical concepts, drawn from thermodynamics, information theory, psychiatry and so on, lend themselves to becoming anything but interesting metaphoric leads inside quite another system of metaphors. To take these leads literally means to develop forbidding, and indeed afflictive, contraptions of verbal machinery whose usefulness is far from proven. It means losing touch with the communal sense, clouding, too, the Mirror of Being with far less to show in return. It becomes the abstruse game for an elite, like Hermann Hesse's Bead Game in the Kingdom of Castalia – but without the corresponding elite to play it.

Science does have a universal function in that it represents the ordering capacity of thought. In the face of such chaotic situations as occur, for instance, in literary criticism, it still represents principles of order, such principles as do not come out of machines. It makes room for adequate 'meta' speculation. It does have, beyond the range of controversy, a meta-physics, and that is mathematics itself. It also has a meta-mathematics, and it is willing to discuss meta-languages. In the construction and choice of theories, it is guided by principles which are ultimately aesthetic, like simplicity and symmetry.

Apart from that, it has in itself something entirely humanistic, namely its interplay of creative images, its own experiences in the search for truth, which tie up with all other forms of search. In the thought of such men as Henri Poincaré and Hermann Weyl, one finds all the levels of culture tied in with their personal speculation; not merely the bare bones of method, but the philosophical awareness, the contemplative capacity and the dense intuition which are commonly ascribed to traditional thought. If humanists were as open to the world of scientific ideation (which has nothing to do with special results) and as comprehensive of the metaphors of science as those men were to the metaphors of literature, history and religion, there would be little cause for the battle against windmills, and worried minds would not have to be reminded of Blake's words: "Let God me keep – from single vision and Newton's sleep." It is the monopolistic single vision, from whatever angle it may come, which is destructive of the dialogue and of the free play of critical discernment.

Thus, the metaphysical accent is never lifted, it only shifts according to time. The scientific theodicies of the nineteenth century

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have lapsed into oblivion, the illuministic offensive is floundering in formalism, science is in the absurd position of having to explain that 'basic research' is *also* useful. It is then somewhere else that men will search for the essential; contempt of pretense, horror of non-being and of the dictatorship of banality even when dressed up in electronics, a truth which responds to their search for freedom, lightness, genuineness, in short, for a world that should make sense.

The Mirror of Being never breaks completely, it only shows in its image plane new Metaphors of Being. Science has dropped with unconcern the Platonic implications and overtones of its youth. It had once been the foundation of metaphysics; today, it professes proud indifference if metaphysics finds outside supports to negate science itself. But as it turns out that Platonism, too, and independently, is now negated on that same outside, science might well begin to wonder about this strange coincidence, and, seeing itself through alien eyes at last, begin to feel the discomfort of its displaced position.

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Contemporary Science and the Contemporary World View

PHILIPP FRANK

FROM some quarters the suggestion has been made to stop research in science for a time, because it threatens to bring about eventually the destruction of mankind. One is told one should rather devote more effort to work in the field of the humanities. The hope is that in this way ethics and religion will develop to a level at which they are able to adapt the human mind to the threat of contemporary science. There are, of course, old myths according to which mankind was once forced to a moratorium on scientific research. Chapter eleven in Genesis tells us that the children of men had made great advances in mechanical engineering. By introducing brick and mortar construction they built a great city. "And the Lord came down to see the city and the tower, which the children of men builded. And the Lord said 'Behold, they are one people, and they have all one language; and this is what they begin to do: and now nothing will be withholden from them, which they purpose to do. Come, let us go down, and there confound their language, that they may not understand one another's speech.' So the Lord scattered them abroad from thence upon the face of all the earth: and they left off building the city." Scientific research had to stop for a time and the children of Adam had to turn to the humanities: they had to study languages.

We can learn from this biblical story that there has been an old tradition according to which exaggerated scientific and technological advance is dangerous for mankind and a direct intervention of God had to produce a moratorium on research. In our century the work in science has evidently recovered so well that we now can hear quite a few voices calling for a new Babylonic confusion.

It has been said again and again that there is an exaggerated emphasis on science in our educational system which produces undesirable effects in the personalities of our students. Many educators – and every grownup claims to be an educator – have made

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the point that the neglect of the humanistic studies is responsible for the general decline in spiritual values and, perhaps, in human values in general. The mind of educators manifests itself in the most conspicuous way in commencement speeches, and there we frequently hear the assertion that this state of affairs leads to an emphasis on 'facts' at the cost of values.

However, a poet and humanist like Archibald MacLeish regards this objection as superficial. His own objection to science as the main topic of education is rather that science deals too little with facts and concentrates on abstractions. "This sort of thing has consequences," writes MacLeish in the *Atlantic Monthly* (March, 1956). "Abstractions have a limiting, a dehumanizing, a dehydrating effect on the relation to things of the man who must live with them. The result is that we are more and more left, in our scientific society, without the means of knowledge of ourselves as we truly are or of our experience as it actually is." According to MacLeish, science gives us only abstractions of the world; we do not learn what our world really *is*. "Science can abstract ideas about apples from apples . . . but poetry does not abstract. Poetry presents the thing as the thing . . . the true child of abstraction can't know apple as apple . . . you can't know man as man. All you can *know* is a world dissolved by analyzing intellect into abstraction – not a world composed by imaginative intellect into itself."

We can find similar ideas in the discussion by literary men of the difference between the general world picture of the sciences and the humanities. Thus Aldous Huxley writes in his little book *Science, Liberty and Peace* (New York, 1946), that the scientists and their followers tend to accept the world picture which is implicit in the theories of science as a complete and exhaustive account of reality. Huxley insists that "the scientific picture of the world is inadequate for the simple reason that science does not even profess to deal with experience as a whole, but only with certain aspects of it in certain contexts." He contrasts the few abstractions of which science consists with "the infinitely rich totality of given facts." For these reasons, students who are brought up in merely scientific thinking will know only a poor and dry, geometrical and mechanical skeleton of the world. They will feel helpless if exposed to the full reality of the world.

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Other authors, viewing science as a dehumanized abstraction, conclude that science cannot have any influence on philosophy as a world view which determines our way of life. Evidently this guidance should be left completely to irrational sources of knowledge, for example religion, metaphysics and, implicitly, political philosophy. But, in fact, this "dehumanizing" and "dehydrating" influence of science has had at all times an important impact upon man's ideas of his place in the universe and, therefore, upon his general philosophy of life. This impact is established by empirical observation with the same certainty as any empirical fact of human or natural history. The ancient conflict between Epicurean materialism and Platonic idealism had its basis in the scientific conflict between the hypothesis that the earth and celestial bodies (sun and stars) are all made of the same material and the ancient belief that terrestrial and celestial materials are fundamentally different. Newton established a theory of the universe according to which the celestial bodies (including comets) move by the same laws as stones and projectiles that are launched by man; and the Newtonian philosophy was the basis of Jefferson's democratic ideas. In our century, the theory of relativity has been interpreted frequently as favoring idealistic philosophy because physics no longer speaks about the "real length of a body" but about its "length for an individual observer." This is taken to mean that physical science deals with mental phenomena instead of with material objects. In a similar way, in quantum theory the physicist does not describe the objective position or the objective orbits of particles, but the measurements made by observers under certain circumstances. Both theories seem to oppose the mechanistic and materialistic philosophies of the eighteenth and nineteenth centuries and to favor a mentalistic picture of the world.

As a matter of fact, the view that science is the product of abstraction from our rich and full experience is rather misleading. It has become more and more clear by the evolution of science in our century that the principles of science are not dehydrated abstractions but a system of symbols that is produced by the creative imagination of the scientist. This has been nowhere demonstrated as clearly as in Einstein's Herbert Spencer Lectures (given at Oxford, 1933) on the Logical Foundations of Theoretical Physics. There is no process of abstraction by which we can proceed from

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our experience with moving bodies to Newton's laws of motion or to Einstein's equations of motion in a gravitational field as they are advanced by the general theory of relativity. While our experiences of motion can be described in common-sense language, the general principles (like Newton's or Einstein's laws of motion) contain symbols like "curved four-dimensional space" or "length relative to a system F" which do not belong to the common-sense language which we use for the description of our daily life experience. In the same way, the principles of quantum theory contain words like "probability of a particle to be at a certain place" or "ψ-function of a certain field of force" which are not to be found in our common-sense language.

The connection between the general principles (like the equations of motion in the general theory of relativity) and the common-sense level consists in the following: from the general principles we can derive, by long mathematical chains, statements which describe directly observable facts and which can, therefore, be formulated in a common-sense language. Einstein stresses the point that the advance in science is connected with an increasing remoteness of the general principles from statements of our common-sense language. As a matter of fact, even the statements of Newtonian physics cannot really be formulated in common-sense language, but in the relativity and quantum theories the impossibility becomes obvious.

The more remote the language of the principles is from common-sense language, the longer becomes the mathematical chain that connects these principles with the statements which describe the actually observable phenomena by which the theory is checked. Sometimes the chains are without precise end. We must not forget that these chains do not consist of mathematical deductions only. We would never arrive at a statement that could be checked by actual physical operations unless the chain contained at some place operational definitions by which a connection between the symbols at the top and the measurements at the bottom was established. In theories like the quantum theory, the presentation of operational definitions becomes a difficult and controversial task.

One cannot wonder that there has always been an urge to connect the principles with common-sense language by some shorter and more direct way. There has been a longing to restore the situation in which the general principles themselves are congruent to common

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sense. Today we have the impression that Aristotelian and Thomistic physics had this property. The attempts to give direct common-sense interpretation to the principles of relativity theory and quantum theory have played a considerable role in our time. Thus the expression "length relative to a certain system of reference" has frequently been replaced by "length relative to an individual observer" who was even occasionally referred to as "Peter" or "Paul." According to the theory of relativity there is an influence of motion upon yardsticks. Hence, every description of a length measurement has to contain the speed of the yardstick. But by referring to "length" as the sense impression of "Peter" or "Paul" the dependence of length upon the system of reference becomes a dependence upon the mental state of "Peter" or "Paul." This is the short circuit by which the expression "length with respect to a system of reference" becomes an expression of common-sense language; but now it asserts that there is an influence of optical sensation upon the mental state of "Peter" or "Paul." As soon as we replace the expressions that occur in the theory of relativity by these anthropomorphic common-sense terms, the physical theory becomes a kind of psychological theory. From this common-sense interpretation the result is derived that physics actually speaks about the mental phenomena of individuals. Then it is quite natural to interpret modern science in favor of an idealistic or skeptical world view and to deny that science can provide knowledge about physical reality. In a similar way, in quantum theory, the impossibility of introducing position and velocity of a particle at a certain instant of time as state variables has also been interpreted by statements in common-sense language – by a "short circuit," without the long chain that leads to observable phenomena. In one such interpretation the position and velocity of a particle at the same instant of time are said to be inaccessible to the research abilities of human beings, and according to another interpretation, these quantities are actually not strictly determined but vague. If we use the common-sense meaning of the terms employed, this can only mean that the world itself is something vague and can be investigated, not by the methods of science, which are striving for precise and logical results, but by methods used in investigating the "irrational" and "spontaneous" aspects of the world: by metaphysics, religion, mysticism. So some have seen in modern physics a possibility of reconciling science with religion and metaphysics.

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From the scientific viewpoint it is impossible to interpret the principles of quantum theory in common-sense language, except by deriving from them observable conclusions; "short circuits" between the principles of quantum theory or relativity theory and common-sense language are within scientific discourse, strictly speaking, impossible. Regardless of how great the effort in this direction is, the results achieved are always vague and, to a high degree, arbitrary. This means, of course, only that they are "logically arbitrary"; they cannot be derived with certainty by logical operations. But "arbitrary" does not mean that these common-sense interpretations are the result of our "free choice." The choice is, as a matter of fact, determined by our "values," and our predilection for a certain philosophy of life, since different common-sense interpretations could and would support different philosophies of life.

A familiar example is given by the Einstein theory, according to which a mass can be "converted" into an energy. This conversion of mass is, in the common-sense language, a "disappearance" of mass or a "dematerialization," and it would imply not physics but magic and the occult. In advancing the theory, the physicist does not use "mass" as a word of the common-sense language. If forced to introduce common-sense language, he would have to say either that energy is mass and one kind of mass is converted into another kind of mass, or else that mass is basically energy and that there is no "mass" in the common-sense meaning of the word. The first interpretation would favor materialism, the second idealism or spiritualism. Contemporary Soviet philosophers have frequently written in favor of the first interpretation, holding that the other would be antagonistic to the political philosophy supported by the government and the ruling party. In the opposite camp, many attempts to "refute materialism" have invoked the second interpretation, which abolished matter.

The introduction of common-sense language where it does not belong has also played a role in domains far removed from physics. If we introduce into theology expressions like "almightiness of God," or "goodness of God," they lead certainly to contradictions, just as the introduction of "position and velocity of a particle at the same moment" leads to contradictions in atomic physics. Obviously all such expressions denoting qualities of God are terms of our common-sense language. To avoid such

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terms in theology the notion of a "God without qualities" has been introduced – an example of the attempt to cast the principles of theology in a language other than our common-sense language. But this so-called "negative theology" and other such doctrines always have to fight against infiltration by common-sense expressions; and hitherto no language has found the general acceptance in theology as, for example, the symbolism of quantum theory has in physics.

If we want to understand the impact of twentieth-century science upon man's general world picture, we have to consider the popular assertion or hope that twentieth-century science may be easier to reconcile with religion and ethics than was the case in the eighteenth or nineteenth century. As a matter of fact, all these attempts at reconciliation have been attempts to produce a short circuit from science to theology analogous to the attempted short circuit from the principles of quantum theory to indeterminism and free will. Briefly, the hope for reconciliation has not been based upon science, but upon the vague interpretations of scientific principles by the introduction of common-sense language.

The British philosopher Broad wrote once that there has been only one plausible argument for supporting traditional religion by science: the existence of scientific laws which are "simple" compared with the immense multitude of "facts" that can be derived from them. A priori, it is not self-evident or even plausible that such laws should exist; but science has found that they do exist. The belief that nature is ruled in every respect by a few such laws is the content of what Einstein called "cosmic religion." But Einstein always maintained that for this argument it does not make any difference whether those laws are Newton's laws of mechancs or the laws of relativistic physics or the laws of quantum theory provided that these laws are helpful in comprehending nature by permitting the derivation of a multitude of facts from simple principles. Whatever the laws are, they give, in this parlance, testimony of God's presence in the universe.

I believe that the advances in philosophy which have been stimulated by twentieth-century physics, like relativity and quantum theory, are not advances in metaphysics but advances in semantics. Twentieth-century science has taught us that the fundamental

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vocabulary for formulating the principles of science can and may have to be very different from our common-sense language, and that, as a consequence, a long chain of difficult arguments is necessary in order to draw testable conclusions from these general principles.

We learn from twentieth-century science that the main advances of science depend not only on the discovery of new facts but on the invention of a new language that can connect these facts with simple principles. We remember the scriptural admonition "Do not pour new wine in old bottles." Einstein used to say that what interested him in the liberation of nuclear energy was not its military or peaceful utilizations but the fact that the fundamental law for these energy-liberating reactions can be logically derived from the principle of relativity. In the same vein, P. W. Bridgman pointed out in the essay "The Prospect for Intelligence" (Yale Review, 1945) that the impact of twentieth-century physics upon human values is twofold. Firstly, the new discoveries in the realm of very small and very large distances and masses have certainly had a great influence upon man's estimation of his position in the universe. "However," writes Bridgman, "the second aspect of the modern epoch in science is, I believe, of incomparably greater significance. The new facts have proved to be so deeply at variance with what had been conceived to be the possible order of nature that the physicist has had to dig down into an analysis of the fundamental tenets of thinking, and has to revise his entire conceptual structure."

This revision, required by the circumstance that the vocabulary used in the principles of science is so remote from our common-sense language, is apparent on reading almost any book on the general principles of quantum theory. Long passages are devoted to clearing up the relations between the technological expressions and our common-sense language. For example, in quantum theory the term "particle" is employed as a thing which has no precise position and velocity, and so is clearly incompatible with the full common-sense meaning of this word. I once asked Niels Bohr whether it would not be practical to eliminate the term "particle" completely from quantum theory. Bohr agreed that one could do so in the interest of unambiguity. But our intuitive thinking in mechanics is strongly tied to the concept of a particle. What we use in quantum theory has some properties of the common-sense particle, but not all of them. As a conceptual tool this "quasi-particle"

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is helpful because we can use some of our common-sense judgments about its motion; it is stimulating for the thinking of the physicist, particularly the experimental physicist.

This is why the concept remains in the theory, despite its patent dangers. Bridgman rightly makes the point that in our discourse on religion, politics or ethics, we are speaking continually in terms which we may or may not be using in their common-sense meaning. There is no doubt that political or religious discourse on general questions uses freely terms like "freedom," "democracy," "well-being of the community," etc., which are not actually to be taken in their common-sense meaning. Bridgman thinks that a clear separation between the different levels of meaning in our political or religious discourse would destroy much of the misunderstanding which makes human relations difficult. What we can learn from contemporary science for our general world view is the technique of analyzing the meaning of terms. This analysis is inseparable from doctrines like quantum theory. Without a precise formulation of the operational meaning of terms it would be impossible to draw conclusions from these principles about observable facts. Specifically, Bridgman has stressed that the application of this technique would reveal a great many questions put by philosophy and theology to be as meaningless as speculations concerning the absolute speed of the earth or the precise position and momentum of a particle.

At the end, I return to the assertion of MacLeish that science gives only abstractions while poetry presents "reality." This distinction is well analyzed by Richard von Mises in his book, *Positivism, an Essay in Human Understanding* (Harvard University Press, 1951). We have seen that the main activity of science does not consist in producing abstractions from experience. It consists in the invention of symbols and in the building of a symbolic system from which our experience can be logically derived. This system is the work of creative imagination which acts on the basis of our experience. The work of the scientist is probably not fundamentally different from the work of the poet. "Reality in its fullness" can be grasped neither by the scientist nor by the poet. Reality can only be experienced, never presented; we cannot even know what it would mean to present "reality." Every presentation, scientific or poetic, proceeds by creating symbols. If we ask

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which of them comes closer to reality, we employ the word "reality" again in a twilight region where it is not clear whether the word is used in its common-sense meaning or not. If somebody would claim to present the "full reality," I would question modestly, "Really?"

I sense that some people may say: "You have spoken only about words; we should prefer to hear about facts." However, science and all other types of knowledge, including art, consist in building up systems of symbols; words are merely one kind of symbol. Non-scientists often believe that science consists in making observations, in accumulating experience. But this image misses the point. At every moment of our life we perceive data of experience, yet by recording them we do not get science. Science begins only when we invent a system of symbols which can bring order into our experience. For building up science, the creation of words and their syntax is as important as experiments. A part of our science is contained in the vocabulary and the syntax of the English, French or German that we use. And this is a province of the philosophy of science; for, as L. Wittgenstein put it in the book *Philosophical Investigations* (London, 1954): "One might give the name 'philosophy' to what is possible *before* all new discoveries and inventions."

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The Growth of Science and the Structure of Culture

Comments on Dr. Frank's Paper

Robert Oppenheimer

It is a good and happy occasion that we should be celebrating the achievements of Dr. Frank and Dr. Bridgman. In this group of papers we have been using the words "the influence of science on culture" in three related, but different, senses to discuss three separate questions. The first has to do with the extent to which cultured and thoughtful people know something about the content of science; we need not exclude a knowledge of its methods, because the two are inherently inseparable. The second question is whether this knowledge provides useful analogies between one science and another, or between one science and a part of rational life that is not normally thought of as scientific. Think, for instance, of the powerful notion of entropy, which comes from a very special branch of physics, and which is certainly useful in the study of communication and quite helpful when applied in the theory of language. The third question goes beyond the knowledge of a culture about the sciences, and beyond the enrichment of a culture that may derive from that knowledge. This is the question whether what has been found out in science can and should have ontological bearing, that is, whether it leads to, whether it justifies, whether it should justify, the drawing of conclusions about the nature of reality.

We are, I think, all clear that the first of these influences, though not easily achieved, is indeed desirable. It is desirable that culture be enriched by knowledge of what has been discovered in the specialized sciences. I am clear that the second influence is also desirable: analogies from the sciences, though they need correction, refinement, often even rejection, are a fruitful part of the life of reason. I think that we are all very shy on the third sort of influence; to this I shall return briefly. Both Dr. Bridgman and Dr. Frank

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have devoted a good deal of their lives to trying to get the first problem in better order, to trying to make sure that what is generally known by educated people about science, and specifically about physics, is something true, that wrong conclusions have not been drawn, the wrong pictures not evoked.

Recently I reread Dr. Frank's book of 1938, *Interpretations and Misinterpretations of Modern Physics,* devoted half to the special theory of relativity – which has played so dramatic and great a part in Dr. Bridgman's life – and half to the quantum theory, which, discovered twenty years later, has played an equally dramatic and great part in the life of the generation following Dr. Bridgman's. We read with the closest attention and interest what Dr. Frank has written of the lessons of atomic physics and the theory of complementarity, and of what Bohr has made of these. I may say that in every respect I concur with what Dr. Frank has written: that this is a sober and faithful description of what goes on in atomic physics; that in its application to psychology it is deep and important, but not really quite new to the philosophy of science; and that in its application to biology it may very probably not be so.

I would like to make my report in the form of comments, starting with what Dr. Frank has said. My comments have to do with the nature of the interaction between scientific discovery and our common culture, with what people who are not scientists know of science, think of it, and make of it. There are six comments.

I. The first comment starts with Dr. Frank's recognition of the difficulty in correctly drawing relevant information from contemporary science into the general culture as a linguistic problem. This there certainly is; but there is a far more difficult and deeper problem even than the linguistic problem. Science starts with preconception, with the common culture, and with common sense. It moves on to observation, is marked by the discovery of paradox, and is then concerned with the correction of preconception. It moves then to use these corrections for the designing of further observation and for more refined experiment. And as it moves along this course the nature of the evidence and experience that nourish it becomes more and more unfamiliar; it is not just the language that is strange.

This long chain, which creates such desperate problems of education and communication, is only in part a chain of logic. This

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very important mathematical side plays a decisive part in theoretical physics. It is not yet such an important element in biology and may never be. It is not such an overridingly important element even in chemistry. The feature common to all these sciences is that the experience the scientist describes starts with the experience he has in common with all men and rapidly becomes the experience – and I use this terrible word "experience" for the content of his daily professional life, the things he looks at, the things he does, the experiments in which he engages, his communications about them – very soon comes to be that of a world apart. In an early science, one that is just begun, the difference is not very great. In a science as old and as specialized as physics, it is enormously great. We talk about things that do not in any way enter into the experience of non-physicists. Most of the things that we talk about in our professional life do not enter into the experience even of chemists and biologists.

When Newton formulated his laws of motion it had taken three centuries to overcome the sense of the strange, the bizarre and the wild in the idea of inertia; the idea that, I suppose, was first perceived in the Paris of Buridan. But many of the things that Newton's laws dealt with were reasonably accessible to common experience; they had been talked about in a way that made them part of intellectual life for two millennia. It is, therefore, not unreasonable that a revolutionary discovery about them should have had some sense of impact on thoughtful people. Even more was this true of the law of gravitation, though caution is needed in understanding this impact lest we mistake the plausible stories of the textbooks for the course of history.

Yet contrast this history of Newton's time with relativity or quantum theory, for which the experience itself is not available to the lay scholar. The experience is built on a world of physics he does not know. It is built on experiments, on ideas, on logic and on mathematics which are not part of his resource. It is, indeed, a long way away for him.

Let me give a contemporary example. It has to do with the difference between right and left. We, in ordinary human life, recognize the difference between our two hands. We trace this back to the existence of chemically opposite forms – right- and left-handed forms which are equally possible, but one of which happens to have played a big part in organic chemistry. From the

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point of view of atomic science this remains an accident of history. For we have always been confident that as one entered the atomic domain there could be no inherent difference between right and left; the laws have to be symmetric with regard to right-handed and left-handed structures: space itself shows no preferred sense; there were no built-in screws in the atomic world.

It is an open question whether space has this symmetry on the cosmological scale because we have learned to think that the structure of space is determined by the disposition of matter. In the current cosmologies there is this built-in symmetry; but Gödel invented one a few years ago in the quest for a cosmology in which one could give no meaning to cosmical simultaneity: in this there is a built-in screw in the motion of matter, and therefore in the geometry. It also turned out, to his pleasure, that the time of such a universe may be cyclical, and that in each cycle the time goes, not backward, but forward. This is a good example of Dr. Frank's caution that the words of physicists do not necessarily mean what they appear to mean to the lay ear.

An example of something that is at the moment conjecture, which may soon be a real piece of progress in atomic physics and which may well turn out to be wrong, is the proposal that, on a very small scale, there are objects in the atomic and subatomic world which can exist only in a right-handed or left-handed form, that space does have this lack of symmetry and that the two forms are not equally possible. An element of all earlier atomic physics and chemistry has been that the two must exist together; many beautiful phenomena arise from the necessary coexistence of the two. This proposal would, if true, be something new; and since it deals with the structure of space, one would say that it is very important; we ought, if we are more certain about it, to tell everyone all about it. Yet it is obviously of no interest to men except insofar as they are following in honest detail the physics which defines it. That is true whether or not this piece of intelligence, which has been suggested by the two Chinese physicists Yang and Lee, is the correct interpretation of the evidence.

In much the same way, one has the impression that, although there were certain linguistic difficulties in Darwin's work, because the taxonomists by their nomenclature had gone as far as anybody could to make biology unintelligible, there was no insurmountable difficulty for the layman in understanding what he was talking

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about. Why these people came to be so excited about it is another matter to which we must return. But that they knew what he was saying, that it was defined in terms of common sense and common experience, is at least one of the conditions for its having an enormous impact: it could be understood. Mendel was hardly understood. Long neglected by the profession, his work has had little apparent effect on general thought. The development of a chemical interpretation of heredity by Watson, Crick, and their successors and amplifiers is probably a giant stride in the reduction of the organic realm to the inorganic. So too is the confirmation in Urey's laboratory of Oparin's conjecture as to how organic material can be made from inorganic. This reduction is, of course, far from complete; conceivably it may never be complete. But these findings constitute remarkable progress. They do not appear to interest very much the philosophers, the writers and the literate public, because they are already defined in terms which are too remote and too inaccessible to be a meaningful part of their life.

We have had, I think, in the impact of Freud, again a situation in which his work referred largely, as in *The Psychopathology of Everyday Life* and *The Interpretation of Dreams*, to experiences that people could verify. The terminology he used – the anthropomorphic and dramatic terminology for the elements of the human psyche – was of course also familiar, and even primitive. Thus the whole difficult problem of unfamiliar experience and concept that appears in abstract science does not exist for much of Freud's work. Whether we are now in psychology in a situation where technical experience makes a barrier between general understanding and the science, I do not quite know. This was certainly not true of much of Freud's writing.

Thus in the history of the sciences there is likely to be a period, their hinge, when they begin to come out of common sense, when they come to find that the common view of this experience is not an adequate explanation, when creative synthesis begins. That is the time when there is meat in scientific discovery to enrich human life. That is the time when the content of a science may indeed influence culture. Of course it is also the time of the abuses of scientific discovery of which we have heard so much.

II. The second comment is a modest one. One thing science can do, and rarely does: it can correct the inherited views that it

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has by accident at another stage given to common sense, and which turn out not to be true. It can undo its own errors. Even this is not easy. We think, for instance, of the common-sense notion of chance: this does not distinguish sharply between things of which the causes are not known and the things of which the causes cannot be known and cannot be assigned. When we talk about the fall of a die, or about the fluctuation in weather, we say we do not know their origin: it is a chance. No physicist of the nineteenth century would have contemplated in a serious way the proposition that he could not find out how the die would fall if he took the trouble. Nor should we today. Here chance appears, in other words, as a practical notion, or at least in part a practical notion; as a limitation of what is profitable, sensible, appropriate to do.

Inherent in the quantum theory, as it now stands and as it has stood for three decades, are elements of chance. These elements of chance are occasionally relevant to large-scale things; they are all-important surely on the atomic scale. But this chance corresponds not to our having failed to find out the cause, but to the logical impossibility of assigning a cause. Much has been made of the fact that one cannot prove this impossibility with both complete rigor and complete certitude. But this is hardly more than that one can prove nothing in science with complete rigor and complete certitude, because one can prove with rigor only if one assumes that one's description of the world is right. That in turn can only be made overwhelmingly probable by a massive, intricate, subtle and immensely reassuring confrontation of the description with reality, that is with experiments and with experience; it cannot be made certain. I think one has as much reason to say that there is an element of chance in this more abstract sense as one has to make *any* other assertion based on specialized experience or science.

There is always, of course, a lack in cogency in going from any scientific experience to an ontological statement. There can be no isomorphism between the two. One reason is the nature of the material of science, the finiteness of its material, the limitation and specialization of its material. There can be partial mappings, there can be modes of analogy; and in the worst cases these are reduced to the linguistic mismatch of which Dr. Frank spoke: puns in which relativism and relativity get confused, in which the words *indeterminacy* and *uncertainty* evoke the most familiar and recurrent state of man's psyche.

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III. The third comment has to do with the fact that where science has come into a culture it has not only required a community of experience and understanding; it has also required a kind of resonance. There has had to be some reason why people who were not scientists not only learned – for that, when it is possible, is not unnatural – but also were moved and stimulated by what they learned. The examples in the earlier papers indicate how large a part not completely understood motivations played in the adoption of Newtonian views and the use of Newtonian arguments in the eighteenth century. I think a conclusive proof that this was the case is that in no real sense was Newton himself a Newtonian. He was not led to the Newtonian view of the world by making the very findings which were invoked to support it.

There is another, very different situation in more nearly contemporary physics, in Bohr's concepts of complementarity, in the lessons of atomic physics for the theory of knowledge and man's attitude toward the antinomies of life. Bohr participated perhaps more than any one man in the development of atomic mechanics. To the decisive formal discoveries of Heisenberg, Schrödinger, Dirac, he was very close. Yet he has told me that his interest in the ideas of complementarity long antedated these discoveries in atomic physics. They sprang from his early interests in the complementary character of the introspective and the behavioral description of man, in the complementary character of dealing with experience in the light of love and in the light of justice, and from the familiar yet disturbing tensions of comprehending in one description causal explanation of behavior and moral condemnation of behavior. These traits of experience are part of our inheritance and our tradition; they are neither easy to ignore nor easy to resolve. So too are the complementary uses of words, words as equipment or instruments on the one hand and as objects of study fit for analysis on the other hand; as means of study, or as objects of study. A long and early awareness of these problems made it natural for Bohr to be alert to, to welcome and expand the discovery of complementary features in the physical description of atomic phenomena. I can well think that without Bohr's interest and genius we would not today have a broad theory of complementarity in our culture. Of course, we would still have the same physics; we would still understand what to do in the laboratory and in the classroom and with mathematics, and how to talk about it. We

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would know how to analyze observation and measurement in the atomic domain. But we would not have this immense evocative analogy to situations of psychological and human interest that Bohr has given us. This appears to mean, of course,— if, as I believe, this is a fair example – that scientific discovery enters in an important way into the history of ideas and into culture for historical reasons; these are not reasons that can be established in logic or in rigor.

These historical problems are tough problems, and are seldom completely solved. One can see some reasons why much of Newton's work should have been assimilated in the eighteenth century, as proof of the power of man's reason, as a warrant for confidence in its future. I can guess some reasons – though I may be wrong about them – why Darwin's evolution was assimilated. His notion of development fitted wonderfully with the time-mindedness which the rapid change in the world made relevant in the nineteenth century. His sense of the unity of nature fitted wonderfully with the romantic notion of the unity of man with nature. Of course there were opponents of this view of unity who were also bitter opponents of Darwinism. One can see why Freud also excited an enormous following, why he has in many ways changed our theatre, novel and poetry, the way learned and common people talk, the way we think of ourselves. This is not only because the personification of elements of the human psyche made possible a very familiar, animistic and primitive kind of explanation of human behavior; it is in part also because the newly vivid idea of the continuity of good and evil, and of illness and sin, was made natural and welcome in the early years of this century by the decline of religious and secular authority.

IV. Great changes in abstract science – in science that has reasonably established techniques, criteria of objectivity, and language – that occur in parts of experience not immediately accessible except to specialists may touch and on occasion profoundly alter culture. These alterations cannot be understood as logically rigorous consequences of discovery in science; they are, as I said, contingent on man's interest; they are always analogical. A change in science, whether novelty or discovery, when properly understood, when the linguistic problem is adequately solved, will even then provide only a hunch, a starting point for looking at an area of experience

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other than the science in which it was nourished and born. If an analogy is also based on a pun, that is, on a misunderstanding of the meaning of the words and symbols, it can still provide a hunch, but the chances that it will be a useful hunch are correspondingly and sharply reduced. An analogy taken, let us say, from physics, and applied to a biological system, need not be bad. It is almost certainly wrong; but it is a starting point which may be one of the great ways, by correction and refinement of experiment and analysis, to find a better view. The use of this analogy within a science and between sciences which are not too different, which have some formal relation, is one of the most powerful tools we have.

V. Before I come to my last point, I may raise one question; it may be that someone more qualified will wish to discuss it further. One might think a way in which new ideas would get into the common stream of life would be through their embodiment in technology. One might suppose, for instance, that with the enormous increase in communication, automation, calculation, and of cybernetic devices generally, some people would find the ideas of noise, of entropy, of randomness, of coding, and the general ideas of information theory, indispensable. One would think that if there were enough Geiger counters scattered about, and people listened to them, the idea of chance, in its real sense, could hardly escape human attention. One would think that this would happen even through the schools. Yet I believe that the experience of the last century indicates that not much of this is true. It may be a question that needs to be thought about, whether the carrying into common experience of the fruits of science (which have in them great discoveries and radical new general notions, which exemplify them but which do not articulate or formulate them) is one way of bringing a wider unity to our time.

VI. That unity, I think, can only be based on a rather different kind of structure than the one that most of us have in mind when we talk of the unity of culture. I think that it cannot be an architectonic unity, in which there is a central chamber into which all else leads, the central chamber which is the repository of the common knowledge of the world. I think that it cannot have the architectural coherence of a hierarchy. I know that there is clamor for just that. I think that the clamor is (in part at least) in response to the

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rumors of change in specialized sciences; to the feeling that a great deal is being found out that is indeed deep and important if only it could be made relevant to our time, our life, to human problems generally; if only it could be brought back, intact and integral, into the common knowledge of man.

Actually, in the rapid change, the great discoveries everybody has talked about since the Renaissance, the sum of positive knowledge has increased at an increasing rate. I would even say that it is not fifty years, as was said in the eighteenth century, in which positive knowledge doubles, but something between a decade and a generation. The mass of knowledge grows fantastically; the rate of growth itself grows. It has had on Professor Bridgman the one inspiring effect of testifying to the power of man's intelligence. As such, it is a great thing: let us extend its range; let us get on with it. On too many of his fellow men it has the effect of an unmooring and confusion: "Oh what is the use or hope? How can we keep up with it? What is true one day is no longer true the next!" This is indeed despair of the reason, and leads to the worst excesses of anti-rationalism.

I think that the unity we can seek lies really in two things. One is that the knowledge which comes to us at such a terrifyingly, inhumanly rapid rate has some order in it. We are allowed to forget a great deal, as well as to learn. This order is never adequate. The mass of ununderstood things, which cannot be summarized, or wholly ordered, always grows greater; but a great deal does get understood.

The second is simply this: we can have each other to dinner. We ourselves, and with each other by our converse, can create, not an architecture of global scope, but an immense, intricate network of intimacy, illumination, and understanding. Everything cannot be connected with everything in the world we live in. Everything can be connected with anything.

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The Freudian Conception of Man and the Continuity of Nature

JEROME S. BRUNER

OUR CONCERN is with conceptions of man, with the forces and ideas that have given shape to our contemporary image of man. I need not insist upon the social, ethical, and political significance of this image for it is patent that the view one takes of man affects profoundly one's standard of the humanly possible. And it is in the light of such a standard that we establish our laws, set our aspirations for learning, and judge the fitness of men's acts. It is no surprise, then, that those who govern must perforce be jealous guardians of man's ideas about man, for the structure of government rests upon an uneasy consensus about human nature and human wants. The idea of man is of the order of *res publica*, and by virtue of its public status the idea is not subject to change without public debate. The "behavioral scientist," as some people nowadays insist on calling him, may propose, but society at large disposes. Nor is the idea of man simply a matter of public concern. For man as individual has a deep and emotional investment in his image of himself. If we have learned anything in the last half-century of psychology, it is that man has powerful and exquisite capacities for defending himself against violations of his cherished self-image. This is not to say that Western man has not persistently asked: "What is man that thou art mindful of him?" It is only that the question, when pressed, brings us to the edge of anxiety where inquiry is no longer free.

By the dawn of the sixth century before Christ, the Greek physicist-philosophers had formulated a bold conception of the physical world as a unitary material phenomenon. The Ionics had set forth a conception of matter as fundamental substance, transformation of which accounted for the myriad forms and substances of the physical world. Anaximander was subtle enough to recognize that matter must be viewed as a generalized substance, free of any particular sensuous properties. Air, iron, water or bone were only elaborated forms, derived from a more general stuff. Since that time, the physical world has been conceived as continuous and monistic, as

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governed by the common laws of matter. The view was a bold one, bold in the sense of running counter to the immediate testimony of the senses. It has served as an axiomatic basis of physics for more than two millennia. The bold view eventually became the obvious view, and it gave shape to our common understanding of the physical world. Even the alchemists rested their case upon this doctrine of material continuity and, indeed, had they known about neutron bombardment, they might even have hit upon the proper philosopher's stone.

The good fortune of the physicist – and these matters are always relative, for the material monism of physics may have impeded nineteenth-century thinking and delayed insights into the nature of complementarity in modern physical theory – this early good fortune or happy insight has no counterpart in the sciences of man. Lawful continuity between man and the animal kingdom, between dreams and unreason on one side and waking rationality on the other, between madness and sanity, between consciousness and unconsciousness, between the mind of a child and the adult mind, between primitive and civilized man – each of these has been a cherished discontinuity preserved in doctrinal canons. There were voices in each generation, to be sure, urging the exploration of continuities. Anaximander had a passing good approximation to a theory of evolution based on natural selection; Cornelius Agrippa offered a plausible theory of the continuity of mental health and disease in terms of bottled-up sexuality. But Anaximander did not prevail against Greek conceptions of man's creation nor Cornelius Agrippa against the demonopathy of the *Malleus Maleficarum*. Neither in establishing the continuity between the varied states of man nor in pursuing the continuity between man and animal was there conspicuous success until the nineteenth century.

In speaking, then, of the changing conceptions of man that have inspirited our modern world perspective, I shall be discussing the battle for the acceptance of continuities, indeed, the battle for the right to explore such continuities.

Two figures stand out massively as the architects of our present-day conception of man: Darwin and Freud. Freud's was the more daring, the more revolutionary, and in a deep sense, the more poetic insight. But Freud is inconceivable without Darwin. It is both timely and perhaps historically just to center our inquiry on Freud's

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contribution to the modern image of man. Darwin I shall treat as a necessary condition for Freud and for his success; recognizing, of course, that this is a form of psychological license.

Rear-guard fundamentalism did not require a Darwin to slay it in an age of technology. He helped, but this contribution was trivial in comparison with another. What Darwin had done was to propose a set of principles unified around the conception that all organic species had their origins and took their form from a common set of circumstances – the requirements of biological survival. All living creatures were on a common footing. When the post-Darwin era of exaggeration had passed and religious literalism had abated into a new nominalism, what remained was a broad, orderly, and unitary conception of organic nature, a vast continuity from the monocellular protozoans to man. Biology had at last found its unifying principle in the doctrine of evolution. Man was not unique but the inheritor of an organic legacy.

As the summit of an evolutionary process, man could still view himself with smug satisfaction, indeed proclaim that God or Nature had shown a persistent wisdom in its effort to produce a final, perfect product. It remained for Freud to present the image of man as the unfinished product of nature: struggling against unreason, impelled by driving inner vicissitudes and urges that had to be contained if man was to live in society, host alike to seeds of madness and majesty, never fully free from an infancy anything but innocent. What Freud was proposing was that man at his best and man at his worst is subject to a common set of explanations: that good and evil grow from a common process.

Freud was strangely yet appropriately fitted for his role as architect of a new conception of man. We must pause to examine his qualifications, for the image of man that he created was in no small measure founded on his painfully achieved image of himself and of his times. We are concerned not so much with his psychodynamics, but with the intellectual traditions he embodies. A child of his century's materialism, he was wedded to the determinism and the classical physicalism of nineteenth-century physiology so boldly represented by Helmholtz. Indeed, the young Freud's devotion to the exploration of anatomical structures was a measure of the strength of this inheritance. But at the same time, as both Lionel Trilling and W. H. Auden have recognized with much

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sensitivity, there was a deep current of romanticism in Freud – a sense of the role of impulse, of the drama of life, of the power of symbolism, of ways of knowing that were more poetic than rational in spirit, of the poet's cultural alienation. It was perhaps this romantic's sense of drama that led to his gullibility about parental seduction and to his generous susceptibility to the fallacy of the dramatic instance.

Freud also embodies two traditions almost as antithetical as romanticism and nineteenth-century scientism. He was profoundly a Jew, not in a doctrinal sense but in his conception of morality, in his love of the skeptical play of reason, in his distrust of illusion, in the form of his prophetic talent, even in his conception of mature eroticism. His prophetic talent was antithetic to a Utopianism either of innocence or of social control. Nor did it lead to a counsel of renunciation. Free oneself of illusion, of neurotic infantilism, and "the soft voice of intellect" would prevail. Wisdom for Freud was neither doctrine nor formula, but the achievement of maturity. The patient who is cured is the one who is now free enough of neurosis to decide intelligently about his own destiny. As for his conception of mature love, it has always seemed to me that its blend of tenderness and sensuality combined both the uxorious imagery of the Chassidic tradition and the sensual quality of the Song of Songs. And might it not have been Freud rather than a commentator of the Haftorahs who said, "In children, it was taught, God gives humanity a chance to make good its mistakes." For the modern trend of permissiveness toward children is surely a feature of the Freudian legacy.

But for all the Hebraic quality, Freud is also in the classical tradition – combining the Stoics and the great Greek dramatists. For Freud, as for the Stoics, there is no possibility of man's disobeying the laws of nature. And yet, it is in this lawfulness that for him the human drama inheres. His love for Greek drama and his use of it in his formulation are patent. The sense of the human tragedy, the inevitable working out of the human plight – these are the hallmarks of Freud's case histories. When Freud, the tragic dramatist, becomes a therapist, it is not to intervene as a directive authority. The therapist enters the drama of the patient's life, makes possible a play within a play, the transference, and when the patient has "worked through" and understood the drama, he has achieved the wisdom necessary for freedom. Again, as with the Stoics, it is in

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the recognition of one's own nature and in the acceptance of the laws that govern it that the good life is to be found.

Freud's contribution lies in the continuities of which he made us aware. The first of these is the continuity of organic lawfulness. Accident in human affairs was no more to be brooked as "explanation" than accident in nature. The basis for accepting such an "obvious" proposition had, of course, been well prepared by a burgeoning nineteenth-century scientific naturalism. It remained for Freud to extend naturalistic explanation to the heart of human affairs. *The Psychopathology of Everyday Life* is not one of Freud's deeper works, but "the Freudian slip" has contributed more to the common acceptance of lawfulness in human behavior than perhaps any of the more rigorous and academic formulations from Wundt to the present day. The forgotten lunch engagement, the slip of the tongue, the barked shin could no longer be dismissed as accident. Why Freud should have succeeded where the novelists, philosophers, and academic psychologists had failed we will consider in a moment.

Freud's extension of Darwinian doctrine beyond Haeckel's theorem that ontogeny recapitulates phylogeny is another contribution to continuity. It is the conception that in the human mind, the primitive, infantile, and archaic exist side-by-side with the civilized and evolved.

> Where animals are concerned we hold the view that the most highly developed have arisen from the lowest. . . . In the realm of mind, on the other hand, the primitive type is so commonly preserved alongside the transformations which have developed out of it that it is superfluous to give instances in proof of it. When this happens, it is usually the result of a bifurcation in development. One quantitative part of an attitude or an impulse has survived unchanged while another has undergone further development. This brings us very close to the more general problem of conservation in the mind. . . . Since the time when we recognized the error of supposing that ordinary forgetting signified destruction or annihilation of the memory-trace, we have been inclined to the opposite view that nothing once formed in the mind could ever perish, that everything survives in some way or other, and is capable under certain conditions of being brought to light again. . . .*

What has now come to be common sense is that in every man there are potentialities for criminality and that these are neither accidents nor visitations of degeneracy, but products of a delicate

* Freud, *Civilization and Its Discontents*, pp. 14-15.

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balance of forces that, under different circumstances, might have produced normality or even saintliness. Good and evil, in short, grow from a common root.

Freud's genius was in his resolution of polarities. The distinction of child and adult was one such. It did not suffice to reiterate that the child was father to the man. The theory of infantile sexuality and the stages of psychosexual development were an effort to fill the gap; the latter clumsy, the former elegant. Though the alleged progression of sexual expression from the oral, to the anal, to the phallic, and finally to the genital has not found a secure place either in common sense or in general psychology; the developmental continuity of sexuality has been recognized by both. Common sense honors the continuity in the baby books and in the permissiveness with which young parents of today resolve their doubts. And the research of Beach and others has shown the profound effects of infantile experience on adult sexual behavior even in lower organisms.

If today people are reluctant to report their dreams with the innocence once attached to such recitals, it is again because Freud brought into common question the discontinuity between the rational purposefulness of waking life and the seemingly irrational purposelessness of fantasy and dream. While the crude symbolism of Freud's early efforts at dream interpretation has come increasingly to be abandoned – that telephone poles and tunnels have an invariant sexual reference – the conception of the dream as representing disguised wishes and fears has become common coin. And Freud's recognition of deep unconscious processes in the creative act, let it also be said, has gone far toward enriching our understanding of the kinship between the artist, the humanist, and the man of science.

Finally, it is our heritage from Freud that the all-or-none distinction between mental illness and mental health has been replaced by a more humane conception of the continuity of these states. The view that neurosis is a severe reaction to human trouble is as revolutionary in its implications for social practice as it is daring in formulation. The "bad seed" theories, the nosologies of the nineteenth century, the demonologies and doctrines of divine punishment – none of these provided a basis for compassion toward human suffering comparable to that of our time.

One may argue, finally, that Freud's sense of the continuity of

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human conditions, of the likeness of the human plight, has made possible a deeper sense of the brotherhood of man. It has in any case tempered the spirit of punitiveness toward what once we took as evil and what we now see as sick. We have not yet resolved the dilemma posed by these two ways of viewing. Its resolution is one of the great moral challenges of our age.

Why, after such initial resistance, were Freud's views so phenomenally successful in transforming common conceptions of man?

One reason we have already considered: the readiness of the Western world to accept naturalistic explanation of organic phenomena and, concurrently, to be readier for such explanation in the mental sphere. There had been at least four centuries of uninterrupted scientific progress, recently capped by a theory of evolution that brought man into continuity with the rest of the animal kingdom. The rise of naturalism as a way of understanding nature and man witnessed a corresponding decline in the explanatory aspirations of religion. By the close of the nineteenth century, religion, to use Morton White's phrase, "too often agreed to accept the role of a non-scientific spiritual grab-bag, or an ideological know-nothing." The elucidation of the human plight had been abandoned by religion and not yet adopted by science.

It was the inspired imagery, the proto-theory of Freud that was to fill the gap. Its success in transforming the common conception of man was not simply its recourse to the "cause-and-effect" discourse of science. Rather it is Freud's imagery, I think, that provides the clue to his ideological power.

It is an imagery of necessity, if I may call it that, an imagery that combines the dramatic, the tragic, and the scientific views of necessity. It is here that Freud's intellectual heritage matters so deeply. Freud's is a theory or a proto-theory peopled with actors. The characters are from life: the blind, energic, pleasure-seeking id; the priggish and punitive super-ego; the ego, battling for its being by diverting the energy of the others to its own use. The drama has an economy and a terseness. The ego develops canny mechanisms for dealing with the threat of id impulses: denial, projection, and the rest. Balances are struck between the actors, and in the balance are character and neurosis. Freud was using the dramatic technique of decomposition, the play whose actors are parts of a single life. It is a technique that he himself had recognized in phantasies and

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dreams, one which is honored in his essay, *The Poet and the Daydream.*

The imagery of the theory, moreover, has an immediate resonance with the dialectic of experience. True, it is not the stuff of superficial conscious experience. But it fits the human plight, its conflict, its private torment, its impulsiveness, its secret and frightening urges, its tragic quality.

Concerning its scientific imagery, it is marked by the necessity of the classical mechanics. At times the imagery is hydraulic: suppress this stream of impulses, and perforce it breaks out in a displacement elsewhere. The system is a closed and mechanical one. At times it is electrical, as when cathexes are formed and withdrawn like electrical charges. The way of thought fitted well the common-sense physics of its age.

Finally, the image of man presented was thoroughly secular; its ideal type was the mature man free of infantile neuroticism, capable of finding his own way. This freedom from both utopianism and asceticism has earned Freud the contempt of ideological totalitarians of the Right and the Left. But the image has found a ready home in the rising, liberal intellectual middle class. For them, the Freudian ideal type has become a rallying point in the struggle against spiritual regimentation.

I have said virtually nothing about Freud's equation of sexuality and impulse. It was surely and still is a stimulus to resistance. But to say that Freud's success lay in forcing a reluctant Victorian world to accept the importance of sexuality is as empty as hailing Darwin for his victory over fundamentalism. Each had a far more profound effect.

Can Freud's contribution to the common understanding of man in the twentieth century be likened to the impact of such great physical and biological theories as Newtonian physics and Darwin's conception of evolution? The question is tempting, but not appropriate. Freud's mode of thought is not a theory in the conventional sense, it is a metaphor, an analogy, a way of conceiving man, a drama. I would propose that Anaximander is the proper parallel: his view of the connectedness of physical nature was also an analogy —and a powerful one. Freud is the ground from which theory will grow, and he has prepared the twentieth century to nurture the growth. But, far more important, he has provided an image of man that has made him comprehensible without at the same time making him contemptible.

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Quo Vadis

P. W. Bridgman

It is fashionable to stress the differences between the "sciences" and the "humanities." There are, of course, obvious differences, and for certain purposes and in certain contexts it may be desirable to emphasize them, as, for example, in drawing up a curriculum of instruction or in organizing a university faculty into departments. I believe, however, that the differences are more or less superficial; what is common to the sciences and the humanities is far more fundamental and important than the differences. In the first place, both are human enterprises; this gives them a unity which they cannot escape. Furthermore, they are both predominantly intellectual enterprises, even, if I may be permitted to use the term, enterprises of the intelligence. This I would maintain even if we choose to make a concern with values the touchstone of differentiation between the sciences and the humanities. It is often said that science can tell us nothing about values, and that here lies the fundamental distinction between science and the humanities. Perhaps one could by some tour de force set up a definition of science which would forbid it values, but surely one cannot forbid a concern with values to intelligence. Values can be described, analyzed, appraised, and modified, and these are all activities of the intelligence. We cannot act in any situation involving values without engaging in at least some of these activities.

Whether we practice a science or a humanity we cannot avoid exercising our intelligences. It is to some of the consequences of this that I would call your attention. It is, I think, beginning to dawn on us that there is more to this problem of using our minds intelligently than at first strikes the eye. There are techniques of being intelligent. It is not easy to acquire the proper use of the mental tools which we have thoughtlessly inherited or which are implicit in the construction of our brains. Severe effort and long practice are required.

It seems that we are coming to an awareness of the existence and importance of our mental tools from the side of the sciences rather than from the side of the humanities. The reason is not any reflection on the humanities, but is a consequence of human frailty

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and the fact that the humanities are so much more complex and difficult than the sciences. By far the most important consequence of the conceptual revolution brought about in physics by relativity and quantum theory lies not in such details as that meter sticks shorten when they move or that simultaneous position and momentum have no meaning, but in the insight that we had not been using our minds properly and that it is important to find out how to do so. Although it is no reflection on the humanities that this insight is coming through the comparatively simple situations of physics, I think it *would* be a reflection if this experience of the sciences did not give the humanities pause, or suggest that it is almost inevitable that some modification is necessary in their own conceptual foundations. For would it not be a miracle if an intellectual apparatus which has evolved to cope with the primitive situations of daily life and which has been found to fail when confronted with the comparatively simple needs of modern physics should retain its validity in the incomparably more complex situations presented by human society and the humanities?

Let us now consider in more detail some of the implications of recent scientific experience for the broader question of what is involved in the proper use of our minds. One of the most obvious of the lessons of relativity theory is the importance of careful attention to the meanings of our words. This attention to meanings involves much more than heeding the admonition "define your terms" long accepted by every lawyer and debater. The objective of the lawyer or debater is primarily to secure conformity of verbal behavior and thus to permit communication. But conformity and consensus are not enough to ensure that a term can be used in the way we would like. In fact, the shocking quality of relativity theory consisted precisely in the discovery that such a term as "simultaneity," about which there had been universal agreement when regarded as merely a bit of verbal behavior, did not have the properties it was assumed to have outside the universe of verbal behavior. Words have implications in use which are as important as, or more important than, mere behavioral consensus, and the job of becoming aware of meanings includes discovering what these implications are. Thus, many of our terms are, by implication, capable of being put into statements. A statement, by its very form, implies that it may be true or false. We do not fully know the meaning of a term which is habitually used in statements unless

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we know whether it makes sense to say that a statement containing the term is either true or false, and still more, unless we can tell what to do to find whether the statement is true or false. This sort of analysis is not often made, and when it is made it often discloses things not suspected.

The physicist has by now found a way of dealing with his meanings which is fairly satisfactory for his purposes, and which does not commit him to preconceptions about fields not yet entered. This method of dealing with meanings I have called "operational." The essence of it is that to know adequately the meaning of a term we must be able to describe what we do when we use it. It is my personal opinion that this way of dealing with meanings has a wider application to all our language, in so far as that language is an activity of intelligence as distinguished from a purely emotional activity; but this is a matter of detail which is more or less beside the point I am trying to make here. This point is that we can always ask what the meaning of any term that we use is, and that in answering this question we have to satisfy *some* criterion of meaning. Whether the criterion is operational or not is not important in this context; there has to be some criterion, and if we can explicitly formulate it, we are in a position to judge from our other experience whether the meaning has the significance we had supposed. It will often be found that the term cannot have the supposed significance, just as the physicist's concept of simultaneity did not. I believe that very few of the terms of humanistic — as distinguished from scientific — import have been subjected to an analysis for meaning as articulate as this, and that when they are thus analyzed the entire situation may appear in a different light. In the case of such humanistic terms as justice, freedom, duty, responsibility or right, it will be found, I believe, that the verbal component is unexpectedly large, and that the meanings are applicable only in a universe which is predominantly verbal. Now it must not be hastily assumed that for this reason we must discard these terms — far from it — but a realization of the situation will, I believe, bring about a change of attitude. The resultant remaking of our concepts is still ahead of us.

Concern with meanings is only one aspect of a growing realization of the extent to which we are verbal animals. Philosophers and logicians are not unaware of this. Consider, for example, the

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active field of semantics. The realization is growing that the grammar of a language may almost compel certain attitudes. For example, reification is almost inevitable in a language with the structure of English and in other European languages. One cannot say "I do" without implying "I do *something*," and the something becomes reified. The situation is carried over into physics, where the almost universally accepted identity of mass and energy is the result of an unnecessary and illogical reification of energy.

The implications for logic are particularly interesting. It is popularly supposed that logic deals with something fundamental and universal – it was Boole who used the phrase "the laws of thought" in this connection. But one questions the validity of this point of view when one considers that there are languages, such as some of the North American Indian languages, in which it is difficult and uncongenial to formulate a universal statement, and therefore difficult to form a syllogism. Yet the people with such a language manage to meet the situations of daily life with a survival potential about as good as that of the rest of us. It begins to look as though formal logic, as we know it, is an attribute of the group of Indo-European languages with certain grammatical features.

The concern with words is rather near the surface. Physics has had deeper worries and insights, mainly as a result of the development of quantum theory. One of the most important of these insights has been concerned with the role of the observer. Now for the purposes of quantum theory the observer is highly specialized, and is essentially the measuring instrument. A detailed examination of the unavoidable reaction between instrument and object of measurement provides the justification for the Heisenberg Principle of Indetermination. But the point of view of quantum theory has implications for us much wider than the technical details. It forces us to realize that we cannot have information without acquiring that information by some method, and that the story is not complete until we have told both what we know and how we know it. In other words, we have to remember that we always have an observer. Furthermore, this observer is ourselves, and therefore we cannot get away from him. But getting away from itself is what the human race has been trying to do ever since it started philosophizing or worshipping.

Let us face facts and not fear to say out loud that the one field of

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human activity in which we are most obviously trying to get away from ourselves is the field of religion. This, I take it, is historically true as a statement of what has been involved in the religious activity of the past. The beings and principles which are the concern of religion are beings and principles external to us and independent of us, eternal in the heavens and surrounded with an aura of absolute truth. This absolute truth is thought of as intrinsically knowable, by revelation if not by more mundane methods.

The fact that men have thought in this way has had a most important effect on their overt conduct; one need only consider the Inquisition or the spread of Mohammedanism. In this respect it must be conceded that Toynbee's conception of history is justified, although one may not be willing to assume with Toynbee that the religious attitude must necessarily be as decisive in the future as it has been in the past. Given the view that there exists an absolute truth, and given furthermore the conviction that one has found absolute truth, the intolerance of the Inquisition or the brain-washings of the Communists become logically inevitable. In such a setting, tolerance can be justified only as a Machiavellian measure, to be practiced only while one is too weak to control the social machinery. How secure are we today that the tolerance in which we take so much pride will continue to be accepted as a social virtue? Certainly a large number of our people hold views which if pushed to their logical conclusion would lead straight to intolerance. The reason these people do not act intolerantly is either that they have never thought things through to a logical conclusion or else that they know they do not have the power. I think we have to find other and better reasons for tolerance than any at present widely accepted.

Tolerance is only one of the issues that commonly present themselves in a religious setting. Not only must we find a new basis for tolerance, but we also must re-examine the broader issue of religion as a whole. To do less is to invite the catastrophe which Toynbee foresees for the Western world if our present religious drives are allowed uninhibited play. Since we cannot get away from ourselves, we must find our springs of action within ourselves, a task which the human race has been shirking since the beginning of recorded history. We have to find what admirable motivation is left when we repudiate the almost universal and irrepressible urge of men to

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get away from themselves, something that we are coming to realize simply cannot be done. It seems to me that we are not going to find how to get along without our absolutes by any "return" to points of view held in the past; rather, something vitally new is required which we can now only faintly glimpse. And there is no reason to fear that our aspirations and ideals will evoke emotions less poignant under the new dispensation than under the old.

In this connection the recent experience of mathematicians and logicians with Gödel's theorem is most illuminating. It is a consequence of this theorem that mathematics can never prove that mathematics is free from internal self-contradictions. The realization of this had a tremendous impact, for here was something that the greatest mathematicians had been vainly trying to do. Out of this experience mathematicians and logicians have acquired a new insight – the insight that there are some things that neither they nor anyone else can do with their minds. Perhaps the most devastating point is the realization that the human mind can never have certainty, by either logical, or metaphysical, or mystical methods. The realization that certainty is not logically attainable took Bertrand Russell all his life to acquire, and he acquired it by successively trying in detail one or another purported method of getting certainty – and finding it wanting. Gödel's theorem, as it were, cuts the Gordian knot with the insight that "certainty" is an illegitimate concept.

The list of illegitimate concepts will certainly grow. For it is beginning to dawn on us that in the world of mental activities there may be principles of impotency analogous to the impotency principles of physics. It took a long time to realize that it is impossible to create energy out of nothing or that it is impossible to get energy out of a system without paying the price in terms of entropy. It does not seem unreasonable that there should be corresponding principles in the mental world, or that it should take us longer to discover them, when we consider the incomparably greater simplicity of the physical as compared with the mental world. Some day, I have no doubt, we shall have formulated a set of laws of mental dynamics analogous to our present laws of thermodynamics. As it is, we can glimpse at least one such law in the light of Gödel's theorem. The reason mathematics cannot prove that mathematics is free from contradiction is that there are some things a system cannot do with itself. When we try to get away from ourselves by correcting what our senses or our per-

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ceptions or our reason presents us, it is *we* who are attempting to escape, and whatever the result of the attempt, it will be something of which *we* are aware. Here we have the system dealing with itself. But what we would like to do can neither be done nor even be talked about. Perhaps we have here a worthy candidate for the first law of mental dynamics, namely the law that we cannot get away from ourselves.

It seems to me that religion is the field of human concern in which we have most obviously pushed the common-sense assumption that we can get away from ourselves beyond the bound of validity, and in so doing are trying to do something with our minds that cannot be done. It would be rewarding to look in other directions for examples of intellectual impotency. I suspect that an observer from another planet, contemplating the inability of our philosophers to reach agreement on certain questions after three thousand years of effort, would conclude that in this field we have also been trying to do something with our minds that cannot be done.

Not only are we beginning to realize the general outlines of the way the brain can deal with the external world, but we are beginning to get some glimpse of how it works out in detail. Cybernetics, computer technology, and brain physiology, particularly the electrical study of the brain, are all providing valuable insights. Particularly valuable in this connection are the experiments on the nature of perception initiated by Ames and his colleagues at Hanover and now extended to well over a hundred research centers scattered through the world. These experiments are giving an insight into the nature of the perceptions in terms of which we see our world. These perceptions are no simple and immediate reaction to the stimuli acting on the sense organs, but are a most complicated product involving the past history of the brain, and have validity only in a context harmonious with that past experience. The mental machinery having been once conditioned, we have little or no control over the perceptions which ensue. By malicious manipulation it is possible so to arrange the operation of the sense organs that the resulting perceptions are palpably absurd and impossible, but nevertheless have a compulsive quality that can be appreciated only by experiencing it. One cannot see the experiments without asking oneself what is the significance of this compulsion, or, more generally, what is the significance of the compul-

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sion that the entire human race feels in seeing the world as it does? At the very least, it is impossible to retain the conviction that one is seeing something absolute, independent of the seeing mechanism.

It will probably be objected that the insights we have been urging are all rather negative and destructive. Something more constructive will doubtless be demanded. But a change of outlook as revolutionary as is contemplated here almost inevitably has to begin by being destructive. Our first concern is whether what we have been saying is true, and destructive criticism may be as true as constructive criticism. If the criticism is true, any reconstruction will at the very least have to meet the objections of the criticism, and, of course, in addition find new constructive factors. I would not admit, however, that we are entirely destitute of constructive insights as to methods of meeting the situation revealed by our criticism. But if I had attempted to argue these constructive possibilities, I would have run the danger of obscuring the main point by introducing elements more controversial even than those I have admitted.

The main point is that the human race has not yet found how to use its mind. We are getting at this realization through the sciences, but the sciences have as yet by no means furnished all the answers. One reason is that for the particular purposes of science an incomplete view is adequate, particularly because the sciences are comparatively so simple. But for the wider purposes of the humanities – the complete human scene in all its scope – some more drastic reconstruction is necessary. It is, for example, obvious that the involvement of the humanities with the whole verbal machinery of thought is much more intimate than that of the sciences. I would place as the most important mark of an adequately educated man a realization that the tools of human thinking are not yet understood, and that they impose limitations of which we are not yet fully aware. As a corollary it follows that the most important intellectual task for the future is to acquire an understanding of the tools, and so to modify our outlook and ideals as to take account of their limitations.

This task is not to be accomplished by any "return" to the insights of the past. The insight that there is any problem here at all is devastatingly new in human history. The sciences and the humanities find themselves facing the problem together; it is too

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difficult and too pressing to permit the luxury of a division of forces. Appreciation of the existence and the nature of the problem is the first step toward the invention of the new methods and outlooks that will be necessary to solve it.

It seems to me that the human race stands on the brink of a major breakthrough. We have advanced to the point where we can put our hand on the hem of the curtain that separates us from an understanding of the nature of our minds. Is it conceivable that we will withdraw our hand and turn back through discouragement and lack of vision?

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Prospects for a New Synthesis: Science and the Humanities as Complementary Activities

CHARLES MORRIS

I WISH to consider, from the perspective of the behavioral sciences, the "possible roads by which the sciences and the humanities may reach a common understanding." The position to be taken is this: Viewed in relation to behavior, science and the humanities have contrasting (and at times antagonistic) roles in our culture – but not, as is sometimes assumed, inevitably conflicting roles. The tension which does exist is salutary to the extent that science and the humanities perform complementary functions within the total process of human conduct.

The conception of a complementary relation between science and the humanities is not novel. But it is believed that certain developments in the behavioral sciences can deepen the sense of such complementarity and contribute to a common understanding by scientists and humanists of both the opposition and the interrelatedness of their activities.

There are current today a number of slightly different formulations of the essential features of human action. For present purposes a fivefold analysis is tentatively used. A human being must:

1) know something of the environment in which he acts,
2) select for attention those objects which may meet his needs,
3) act upon the selected objects in certain ways rather than others,
4) let such objects work in turn upon him,
5) do all this in an organized way.

Thus a hungry person must know which objects are food objects, must select among such candidates in terms of the nature of his hunger and other considerations, must attain and eat the selected

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object, must let the eaten food work upon his organism, and must do these things in a certain order.

An analogous situation obtains in the case of group action, as when a number of persons act together to build a bridge across a river. The essential difference here is that various phases of the total action may be performed by different persons – some seeking possible sites for the bridge, others choosing between these possible sites, others doing the acts of construction at the selected place, and others "trying out" the erected structure. In this case, too, the actions must be coordinated, but here the coordination involves the differentiated actions of a number of persons.

It is now suggested that the various kinds of symbols which human beings employ, and also the various aspects of value which persons seek to realize, can be connected with these five aspects of human action. It is not, of course, possible to carry out such an analysis in any detail here; indeed, the successful accomplishment of such a double task is a major responsibility confronting the theorists on human behavior. But if a behavioral orientation can be given to both human values and human symbols, then the behavioral scientist will have extended a hand that the student of the humanities may grasp.

We shall consider first the domain of human symbols. We are all aware that a controversy has raged for several decades over the relation of "referential (or cognitive) meaning" and "emotive meaning," and over the question as to which symbols had which kind of meaning. This dichotomy of referential and emotive symbols, oversimplified as it was, at least had the merit of forcing attention to the various functions in human behavior which various signs fulfil. In this way the current emphasis in the analysis of signs has become to a great extent behavioral in orientation. This is true of Wittgenstein and the British philosophers he has influenced, of such humanists as I. A. Richards and Kenneth Burke, of such sociologists as Talcott Parsons and Robert Bales, and of such psychologists as Charles Osgood and Jerome Bruner – to cite only a few of the many names that might be mentioned.

There have in this development arisen the important idea of "dimensions of meaning" and the view that the meaning of symbols may be described in terms of their position in these *various* dimensions rather than in terms of simply one kind of meaning ("referen-

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tial," or "emotive," or what not). There are a number of proposals as to how many dimensions of meaning exist. In *Signs, Language, and Behavior,* I worked in terms of four dimensions (there called "modes of signifying"); Parsons and Bales have suggested three (or perhaps four) dimensions; Richards has recently proposed a seven term analysis. Charles Osgood has set himself the task of finding empirically, by the use of factor analysis, how many dimensions of meaning there are, and how the meaning of a symbol may be analyzed by giving its quantitative place on each of the dimensions.

At the present stage of rapid development in this field it is not possible to state precisely what the dimensions of meaning are or their relation to the phases and aspects of behavior. But as an indication of the plausibility of such a relationship the following suggestion may be made. *Signs, Language, and Behavior* distinguished four main dimensions of signification as the designative, the appraisive, the prescriptive, and the formative. Designative signification would seem to be linked with that phase of behavior in which information with respect to the environment is required; appraisive signification with that phase of behavior in which preference is to be given to one object rather than another; prescriptive signification with that phase of behavior in which one action rather than another is to be preferred; and formative signification to be linked with the organization of component behaviors into a total act. The analysis in *Signs, Language, and Behavior* furnished no dimension of signification corresponding to that stage of behavior (stage 4 above) which has here been characterized as allowing the object to act upon the actor; perhaps to the former analysis should be added another dimension of signification (perhaps "expressive signification") in which the sign signifies how the utterer of the sign "finds" the object to be as it works on him – as in saying "Fine!" when the bitten-into apple begins to have its way with the eater.

But whatever the details may turn out to be, the main point is that scientists and students of the humanities alike are beginning to envisage meaning in multi-dimensional terms and to gain in this way a "speculative instrument" (to use Richards' phrase) for understanding that the symbols which operate in their several disciplines and activities differ primarily in the degree to which the various dimensions of meaning are involved.

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A parallel situation is developing with respect to the notion of value. It may be unnecessary to call attention to the intensive interest in the topic of value now being shown in psychology, sociology, and anthropology. For the sake of concreteness it is perhaps permissible to refer to my work in this field.

An investigation has been made of the preferences shown by college students in a number of cultures for thirteen possible ways to live (thirteen possible conceptions of the good life). Each of the thirteen alternatives was rated by each student in terms of seven categories, ranging from "seven" for liking the alternative very much to "one" for disliking the alternative very much. The results, obtained with the help of Lyle V. Jones, show that these rating categories can be treated, in each of the main cultures studied, as if they were integers and hence that legitimate quantitative comparisons can be made of the students' conceived values within and across cultures.

Analysis of the ratings of United States students by factor-analytic methods has also revealed five value factors or dimensions as underlying the ratings of the thirteen alternatives. Analysis of the ratings of Indian and Chinese students gave very similar results, in spite of the fact that the preferences for the thirteen alternatives varied widely in the three cultures. Such results suggest the existence of a set of value dimensions which extend across cultural boundaries.

These five value dimensions may be characterized briefly in the following terms:

Factor A: social restraint and self-control
Factor B: enjoyment and progress in action
Factor C: withdrawal and self-sufficiency
Factor D: receptivity and sympathetic concern
Factor E: self-indulgence (or sensuous enjoyment)

Numerical scores on these value dimensions have been computed for individuals, for groups within cultures, and for cultures, and comparisons made in these terms. Evidence has been obtained, for instance, that scores on Factor B (enjoyment and progress in action) correlate positively with the Thurstone temperament traits of Vigor, Impulsiveness, Dominance, and Sociability, while factor scores on Factor C (withdrawal and self-sufficiency) correlate negatively with

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these temperament traits and positively with the trait of Reflectivity. The Sheldonian physique component of mesomorphy (the bone-muscle component) correlates positively with scores on Factor B and negatively with scores on Factor C. It is of interest that Factor A (social restraint and self-control) shows no significant relation with the Thurstone temperament traits or the Sheldon somatotype components, a result of significance for the social sciences since Factor A may be regarded as a socialization variable. Consideration was also given to age and sex differences, and to the differential ratings of the thirteen alternatives by members of various economic status groups and various urban and rural communities.

The results taken as a whole support a "field" theory of value, since biological, psychological, and social determinants all affect the ratings of the thirteen alternatives, and yet neither type of determinant gives a sufficient basis for explaining all the results. By the same token, it follows that the study of value in its totality must be multi-disciplinary.

The question may now be raised as to the relation of the five value dimensions to the five aspects of action which were earlier distinguished. At present no demonstrated relation can be claimed; but that there is some connection seems obvious enough. Detachment (Factor C) is involved at the stage of action in which the actor is seeking knowledge of the environment. Receptivity (Factor D) is required when one object rather than another is favored for preferential concern. Action in the form of dominance (Factor B) is demanded when access to the favored object is to be gained. Self-indulgence (Factor E) is required in "letting oneself go" so that the object may do its own work. Something like Factor A (social restraint and self-control) is demanded in the organization of action, and particularly so in the case of social action.

In so far as some such analysis is defensible, it would seem that the dimensions of value answer to aspects of action and are in fact requirements which must be met if the given aspect of action is to be adequately performed.

It may be noted also that if the value dimensions and the dimensions of signification have the suggested relation to the aspects of action, then they have a parallel relation to each other. The parallelism would be something like this:

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Aspect of action	*Value dimension*	*Signification dimension*
1	C: detachment	designative
2	D: receptivity	appraisive
3	B: dominance	prescriptive
4	E: self-indulgence	"expressive"
5	A: self-control	formative

Such parallelism of the two sets of dimensions may help to explain why the term "meaning" in ordinary speech covers both the notion of significance and the notion of signification.

In the light of these considerations we may now return to the problem of the relation of the sciences and the humanities.

The fact that human behavior has a number of aspects does not imply that in every particular behavior all aspects have the same prominence. There are types of behavior, and these depend upon the predominance of certain components of action over others. Certain phases, for instance, may be prolonged and others abbreviated. One type of behavior might weight heavily the attainment of knowledge of the environment; another may consist largely of the active manipulation of objects; another may prolong the stage of gratification. The situation in which action takes place may favor one type of behavior more than another, and individual differences at various levels of the self certainly play their part in such differentiations. Further, it is a characteristic of social action that the performance of certain acts is institutionalized and delegated to persons operating in socially defined roles. This means, in terms of the preceding analysis, that the stress upon certain dimensions of value, and upon the corresponding dimensions of signification, varies with the type of act, and hence varies with persons and social institutions.

It follows that some strain, and even antagonism, is inevitable, and may be expected at all levels of human conduct: within the individual, between individuals, between individuals and institutions, between institutions, and between cultures. The resulting tension may become disruptive of the individual, of a society, and potentially of all mankind. For the most part, however, such disruption does not occur, and it need not occur as often as it does. To understand this situation is to glimpse one of the possible roads toward the common understanding which we are here exploring.

The point to be emphasized is that differentiations in types of

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conduct, and hence specializations in kinds of values and kinds of symbols, are necessary in the total process of human action and are essentially complementary in function.

If it is important to know the world in which we live, there will be a tendency for specialists and specialized institutions to arise better to perform this function. This will mean an emphasis upon detachment, and upon the designative and formative dimensions of signification fitted to this purpose. In modern form this is the mentality and domain of science.

But equally, since life is more than knowledge, there will be a tendency, and indeed a necessity, for other persons to assume the responsibility for other aspects of human action, and to operate in terms of the dimensions of value and signification which they require. So there will arise critics and artists and moralists and statesmen and religionists performing tasks which are essential for human life as a whole and which are complementary to the task of the scientist.

Thus the situation is not one of "science" versus "value," but of science realizing certain values while other types of activity realize other values. The scientist cannot be blamed if others fail in their responsibility to perform adequately their complementary tasks. A common understanding of the multi-dimensionality of the domains of meaning and of value should encourage scientist and humanist alike to understand their genuine differences and yet to realize the complementarity of their roles in the total human task.

Two comments are in order. The multi-dimensionality of values and meanings does not imply that the complementary tasks which this situation involves can be performed in complete isolation from one another. The fact that social action must be organized makes this impossible. What is done in one phase of social action influences and is influenced by what is done in other phases. Partial independence and partial dependence is here, as often elsewhere, the general case.

Finally, Werner Heisenberg has suggested that a relation of complementarity holds "between the situation in which we have to decide something and the situation in which we study the causes in the behavior of other human beings."* This position is not

* The quotation from Werner Heisenberg is taken from *The Study of International Relations*, by Quincy Wright (Appleton-Century-Crofts, Inc., 1955).

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at variance with the foregoing analysis. Nevertheless, the complementarity of the two situations erects no absolute wall between science and the humanities, and presents no tragic dilemma. In the making of a decision, scientific results may and often do enter, though as only one factor, never as the sole factor. And if science as an institution is only one institution among others, and if man as scientist is never the total man, nevertheless, as institution and as individual activity, science is embedded in the total action of contemporary man. Through his symbolic processes man can move into and out of various perspectives. He can present himself to himself as simply an object in the large cosmos, and he can do this without losing his position as an urgent actor. In this position of urgent actor, man as humanist incorporates at his human center that part of his total activity which we know as science.

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A Humanist Looks at Science

Howard Mumford Jones

I fear my contribution to the discussion of our main topic must be one of confession and avoidance mainly. Like many other persons professionally engaged in the teaching of English, I was badly educated; that is, my graduate work was principally devoted to acquiring lore rather than to interpreting learning, and in consequence I have no metaphysical skill, no mathematical skill, and no scientific skill either in the way of laboratory experience or in the mastery of the grammar and syntax of some branch of exact science. A rebel against the American imitation of German philological training then dominant in graduate schools, I was nevertheless molded by what I rebelled against. The only novelty available to me in the days when George Lyman Kittredge was thundering on the right and John Matthews Manly whispering on the left was to move out from under the shadow of documentary analysis and philological training into the American field, in which the social implications of a young literature offered new possibilities for an interpretation that is now no longer new.

Furthermore, my teaching career began in the South, and I remained in the South for about fifteen years, during a period when conservatism was as rampant as Coca-cola in southern humanities departments. This conservatism was a function of southern scholars to show that they were just as orthodox as scholars in the Ivy League. The inevitable result was not so much a refusal to consider the problem of science versus the humanities as it was a state of complete innocence. We did not know that the problem existed. Scientists were persons who disappeared into laboratories and scholars were persons who disappeared into libraries, and on this simple and satisfactory system we got along very well by ignoring each other.

Autobiography is a form of narcissism, but I shall nevertheless be so far further autobiographical as to confess I never really confronted the science-humanities problem until I went to the University of Michigan in the thirties. There I joined two organizations: a shop club and the university Research Club. The shop club, for

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reasons unknown to me called the *Azazels,* was composed, like other such organizations, of representatives of various disciplines, each of whom was chosen because he represented a specialty and each of whom, on appropriate occasions, was required to make clear to the rest of us some mystery of his craft or his philosophy. The shop club permitted a quality of informal give and take, of question and answer, of conjecture and response, which deflated the pompous, and required the most esoteric specialist to follow Turgenieff's injunction to "simplify, simplify." He had to practice the art of making his ideas plain to minds so trained they could not follow him.

Theoretically the Research Club did much the same thing, but there was a larger number of scientists in it. The club customarily met in a science classroom or laboratory because when a scientist spoke, he had to have blackboard and apparatus and a lantern and lantern slides; as a result the atmosphere, though friendly, was more like that of a public lecture. The scientists were of course broad-minded, listening to humanists who performed no experiments and had no graphs; and the scientists themselves, if my memory is right, initiated a club policy I thought admirable. The policy was this: If in any year there occurred the anniversary of a great scientist or a great scholar dead and gone, the Research Club devoted one of its monthly meetings to the life and career of the illustrious dead. And it was precisely at this point that my education in the problem of communication or lack of communication between the scientist and the scholar began.

For it seemed to me that when the program compelled a scientific specialist to deal with the work of a dead and gone genius, he was almost invariably uneasy; whereas when the program required the same sort of talk from a humanist, he exulted in his task. And by and by it occurred to me that the awkwardness felt by the scientist sprang from at least three causes. The first was pardonable enough – indeed, they were all pardonable – a feeling that he lacked the skill and training needed to present a paper in historical form before humanistic colleagues who were used to formal history. He had to move in a universe of discourse that was novel to him. He had to rival literature, so to speak, on its own ground.

But there were two other, deeper difficulties that have to do with the nature of knowledge. The first of these difficulties was the naïve inability of the scientist to relate the labors of the genius

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to the living thought of the age that produced the genius. I do not mean that a scientist could not tell us, for example, how Spallanzani's researches into the respiration of animals took off from where somebody else had stopped. This sort of thing he did very well; but the succession of experiments as he pictured them was, nevertheless, formal and mechanical, as if they had been lifted out of time and history and performed in a closed box. In a favorable sense one could say of these papers that they were satisfied to demonstrate the defeat of idiocy. You wondered how people got along before Spallanzani, and why they hadn't thought of these obvious tricks. The paper left us with a bit of lore about Spallanzani, which we were grateful for, but it left us no wiser about the intellectual outlook of the eighteenth century in relation to biology, or philosophy, or anything else. Or, if I may change my illustration, if the discussion concerned Newton, the learned astronomer or mathematician discussing Newton might effectively demonstrate the strength and weakness of Newton's experiments and his conclusions, but the eulogist seldom or never succeeded – indeed, he commonly never tried – in demonstrating any relation among Newton's *Principia*, Addison's famous hymn about the spacious firmament on high, the psychological principles of John Locke, and the tactics of Frederick the Great as common products of a world view, a great phase in the development of human culture. I had to learn this sort of thing later from an historian of art.

But there was a third and more fundamental difficulty. The truth is that most of the eulogists didn't really care about Newton and Spallanzani. Let the dead past bury the dead. Science in past time was something the scientist was quite prepared to hand over to these queer fellows, the humanists, on the ground that they might make something of it for their own grist mills. The history of science – indeed, the development of human thought – so far as they were concerned, might be an interesting hobby, a kind of relaxation, but the proper business of science, they seemed to say, was to stand in the present and peer into the future; not to live in the present and turn resolutely to the past. Indeed, if I may momentarily put the case in extreme and misleading form, the past was something the scientists were happily engaged in destroying, or at any rate modifying out of all cognizance. This arose from the commitment of the scientific worker to the destruction of error, which is a part of our inheritance. Error may lurk any-

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where, even in the most universally accepted generalizations, as the triumph of Einstein seemed to demonstrate. The quicker you corrected or obliterated error – that is, the more efficiently you erased some part of the past – the more rapidly you would arrive not only at truth but also at applicability. And applicability meant change, and change is so desirable for its own sake that the triumph of science is to induce the greatest possible amount of change. The notion of how truth (or at least partial truth) came into being was less interesting than the problem of how to eliminate error. And as truth is always present tense, so error is a regrettable inheritance from a past we had better move away from, in a sequence of the type: cottage economy – factory system – automation. I suggest that in this deeply felt, if unconscious, difference between the concept of truth as something in being and truth as something becoming, lies the greatest difficulty in communication between science and humanism. In a loose, general sense the humanist asks: "How did this truth come into being?" whereas the scientist asks: "Where do we go from here?"

This generalization is so patently and monstrously over-simplified I can almost hear the surge of rising blood pressure among outraged metaphysicians. I bow and kiss the rod. The truths of geology, to choose a single science, are obviously implicated in time and history in the one direction, and in the other direction the truths of literary criticism, or at least some literary criticism, are so frenetically up-to-date as to have destroyed even elementary historical knowledge. So likewise many aestheticians regard beauty as a timeless absolute, logicians insist that some sorts of propositions are forever the same, and, on the other hand, some knowledge of the history of astronomy is essential even to astrophysics. Nevertheless I shall defiantly allow my naïve distinction to stand for a moment, at least.

Among humanists it is commonly said it is useless to try to understand modern science because its language is so technical; scientific specialists do not now understand each other – and so, why should the humanists attempt what scientists themselves do not try to do? This argument is in one sense irresistible. In another sense it rests upon a remarkable assumption. The assumption is that the language of science is difficult, and the inference is that the language of humanism is always plain. I think, however, it is not unusual for humanists to remark with pride that Professor So-and-so is so

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learned his latest book can be understood only by ten or twelve in the nation, or in Europe, or in the world – the form of the legend varies. This may be mythical; but I can testify in sober fact from a good many years in the neighborhood of university presses that most books of humanistic scholarship cannot be understood even by the alumni formerly taught by the learned scholars. It makes a difference whose vocabulary is gored. I cannot understand the scientific journals, but then, neither can I understand most of the articles in quarterlies devoted to metaphysics, symbolic logic, and aesthetic theory; and, for that matter, some articles that pass for literary criticism leave me groping for a dictionary. Every trade has its jargon, and I see no more reason to assume that humanists write as clearly as Bertrand Russell than I see reason to expect every biologist to write like William Kingdon Clifford.

I suggest that there is a deep difference between understanding science and understanding scientific articles, just as there is a deep difference between understanding humanists and understanding humanism. Men of good will, desirous of opening channels of communication, look back with nostalgia upon the nineteenth century, when Arnold and Huxley could debate liberal education; Tyndall explain why he was a materialist; Sir Charles Lyell write so that even clergymen could understand him; and Darwin create masterpieces of literature that were also masterpieces of science. One of the central issues in that happy time was the validity of the Christian tradition in an evolutionary world. Putting aside differences between now and then in the training of scientists –Darwin and Huxley were products of the same culture that produced Ruskin and Arnold – I think it of moment that the scientists and the humanists commonly accepted the same ethical and epistemological premises. Whether they were Christians or agnostics, they agreed that the central issue in human psychology was the rationality of man and the central assumption in ethics was the dignity of individual action. If they left the Christian church – indeed, precisely *because* they left the Christian church – agnostics bound themselves to lofty principles of moral action; and humanists, even if they distrusted science as a product of godless reason, defended the Christian tradition on logical and rational grounds.

Contemporary scientists seem to me quite as virtuous as their predecessors; nor do I accuse the modern humanist of being more emotional than the great Victorians. But it seems to me that the

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common premises have altered or disappeared. They have been split between the contenders.

Relativity has come in, and we are all profoundly aware that man's limited impression of time, space, and the universe is not the same thing as the universe per se. The scientist does not, apparently, argue that therefore reason is relative, even though he grants the relativity of reasoning. Reason remains for him a present tool, the most marvelous and supple instrument he has; and he displays no great interest, I take it, in how reason came into being, or whether the human psyche is dominated by the irrational, or whether the conclusions he reaches are just projections of himself or, if not that, symbolical projections of folk myth. By the very nature of his trade he is an instrumentalist. The increasing perfection of the work of reason – that is, of the capacity to formulate a problem, attack it, and create, if necessary, more and more precise machines for measuring and solving it – this, for him, sufficiently validates what he is doing. He is simply a man in the endless procession of Man, and somewhere along the line some one else, with greater or less knowledge, with instruments (including reason) more or less cunningly fashioned, was doing the same thing, only perhaps not doing it quite as well. Even the investigation of the irrational is a function of rationality.

The humanists, on the other hand, have been affected not so much by relativity as by comparison, and the result has been rather more terrifying than comfortable. In the mid-nineteenth century nobody much doubted that the central tradition of civilization was the Egyptian-Jewish-Hellenic-Christian axis. Nobody much doubted that proper classics of art and thought were dotted like stars along a line from Thebes through Athens to London. Nobody much doubted that the fusion of classical wisdom and modern application that was hammered out by Renaissance theorists for the education of gentlemen was as perfect as the Four Gospels.

But when, under the influence of evolution, the humanist began to ask how this tradition came into being, the result eventually reduced him to something like terror. He was compelled to face the fact that there were classics of the East as well as of the West. He confronted hallowed religions that he could not dismiss by the process of converting the heathen to the one true faith. A central tradition in art crumbled as he learned more and more about the Orient and after that about the primitive art of Central America

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and Africa. After Herbert Spencer, who was a bad metaphysician but a great influence, it became increasingly difficult to defend theories of absolute idealism. Worst of all was the increasing power in Western thought, beginning with Schopenhauer, of world-views that stressed the primacy of irrational forces, emotional or biological, not merely in human action but also in human creativity – that is, in the very arts humanism had celebrated as the most efficient check upon irrationalism. So far, indeed, has this change now proceeded that the word "idealism," whether applied to art or ethics or philosophy, has a queer, antique sound. Language itself came under scrutiny; modern commitment to something called "communication" more and more reveals the lurking difficulties of saying anything simply and directly. Language is now held in influential circles to be a device to communicate emotional effects and to conceal not only thought but the absence of thought.

Again I enormously over-simplify; I ignore a vast treasury of riches accumulated by scholarship; I omit counter-movements of protest and order; I ignore the incorrigible cheerfulness of the human race. But I think the inference is irresistible that the drift of thought in Western humanism, as a result of its commitment to the exploration of the genesis of cultures, has led thinkers away from a proud confidence in man toward an uneasiness, a distrust of the transparent unreliability of man's accomplishments.

Let me turn to a specific case. We this year (1956) remember the hundredth anniversary of the death of the great German poet, critic, and social commentator, Heinrich Heine. In 1836 Heine published a little book on the literary tendencies of the Germany of his time, much as Mr. John W. Aldridge might write a book on his own literary generation, as, indeed, he has done. In the course of his book Heine tries to establish the literary and social outlook of the rebellious younger writers of the thirties, known collectively as *Young Germany;* and of them he said:

> A new faith inspires them with a passion. . . . This is faith in progress, a faith which springs from science. We have measured the earth, weighed the forces of Nature, calculated the resources of industry, and behold! - - - we have found that the earth is spacious and wide enough for everyone to build his hut of happiness on it; that the earth can feed us all decently if only each of us works, and none lives at another's expense; that it is no longer needful to preach the blessedness of heaven to the masses of the poor.

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I strongly suspect that to most scientists this looks like a common-sense sort of statement. You work at science, you apply so much of it as you need to a practical problem of land redemption or the Salk vaccine or a more efficient way of manufacturing orlon, and there you are – or rather, there you would be if the politicians would only let you alone. But of course the politicians don't let you alone.

I do not think the humanists are more impressed by the politicians than they are by the scientists, but they do not nowadays kindle to Heine's libertarianism or the dream of happiness on earth insured by success in science. They do not go all out for Heinrich Heine; they go all out for T. S. Eliot, whose *Wasteland* is populated by hollow men; for Kafka, in whose novels all that the characters strive to do adds up to precisely zero; for Sartre, whose existentialist philosophy reduces all philosophy and all philosophers to absurdity; or for Herman Melville, one of whose characters dies insanely hunting a whale, a second of whose characters dies unjustly for a crime the court knows he never committed, and a third commits suicide because he is simultaneously guilty of murder and incest. The world of fashionable humanism is at the present, at any rate, not a cheerful world. It finds the long-run view discouraging.

Difficulties of professional vocabulary are, of course, the great barrier between scientists and humanists. But supposing these could be overcome, supposing the humanists tried to understand science rather than scientific specialties while the scientists concentrated upon humanism rather than on humanistic scholarship, I fear there still remains a profound, unspoken problem. The mood of humanism is in the main at the moment a mood of doubt. It finds the pretentiousness of man over the ages the chief characteristic that has led mankind into folly – the *hubris* of history. Its judgment on man and knowledge viewed historically is that man is, indeed, a thinking reed, but it is more impressed by the noun than it is by the adjective. The scientists, however, excited and stirred by the brilliant achievements of rationality, cannot, I think, quite comprehend why so many humanists are sunk in a kind of cosmic despair. If the two parties to these opposed approaches to knowledge and its trustworthiness could agree upon the meaning of central terms like reason, rationality, objectivity, the human equation, and even humanism – not to speak of faith, humanity, and progress – they might approach sympathy and understanding; but until they are more aware than

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they are today of the profound differences in their approaches to the meaning of knowledge and the use to which knowledge can best be put, the gap will not lessen.

The task of communication is a very great one. In its simplest aspect it is a problem of semantics, as some of the papers in this group demonstrate; but semantics, that important contribution of humanism to the puzzle, is not in itself simple. In its more complex phase the problem is a profound and subtle metaphysical puzzle. But the assumption of opposition between humanism and science is historically untrue; and if at the present time specialism has gone so far on both sides as to make a common understanding difficult, we should not make the mistake of supposing that because it is difficult, it is impossible. Indeed, does not the success of a magazine like *The Scientific American*, which, month after month, in admirable prose makes science clear to the lay reader – does not this success demonstrate that the difficult can occasionally be done? Would that the humanists produced something comparable! It is not enough for experts to approach understanding; the greatest need of the humanities today is to introduce to the more thoughtful part of the American people right notions of science and of the humanities as modes of knowledge and of experience.

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TEXTS AND MOTIFS

Max Weber: "Science as a Vocation"

Introduction: PHILIP RIEFF

WITH THE presentation of the major part of Weber's great essay, the Editors of *Dædalus* establish a Department featuring important documents which have served to define a crucial issue – a Department designed to convert those among us who have lapsed back into the comforting uncertainties of our own disciplines to the larger uncertainties. Whether we shall uncover many essays equal to Weber's is open to doubt; we shall try, for only from the profound and illuminating despair of writings such as this can any affirmative doctrine of man, as seen from the shattered perspectives of the modern arts and sciences, again arise.

In sum, Weber argues that the sciences cannot ask questions of value. Neither philosophy nor theology is now competent to ask, let alone to answer. The arts, if they could make an answer, would only point narcissistically to themselves. No new answer sounds, and the old ones bore us, for they are no longer directed to apparently relevant questions. Perhaps, Weber hints, we ought to abandon such questions and treat every aspect of life as a work of art, something worth while so far as we respond to it. But other minds, not less keen than Weber's, are still at work formulating the questions. And it does not help, as Weber agrees, to dismiss the questions as unscientific; that would be to ignore the complicity of science itself in creating our main embarrassment, to raise first questions long after they had been laid to rest with their ancestors, the Gods.

Men became religious when they had to approach and rationalize the chaos of powers by which they were moved and their destinies sealed. But from Hobbes to Weber there has been an insistent, ironic voice saying that religious man is really, at bottom, political man. All theologies are metaphors of politics. Thus, from the primitive notion that God is power we have advanced to the notion that power is God. Now, as once in some mythic time mankind tested the limits of God, the limits of power are being tested. Whether we shall end with a real Fall is not yet certain, although some testers imagine such things in their most expert dreams. Weber shared in the scientific imagination of disaster. In this essay he sketches the model of all our present disasters. Weber was an honest and passionate scientist; when he had finished constructing his model and found himself enclosed in it, he stayed. To his way of thinking there is no way out.

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Science as a Vocation*

. . . This much I deem necessary to say about the external conditions of the academic man's vocation. But I believe that actually you wish to hear of something else, namely, of the *inward* calling for science. In our time, the internal situation, in contrast to the organization of science as a vocation, is first of all conditioned by the facts that science has entered a phase of specialization previously unknown and that this will forever remain the case. Not only externally, but inwardly, matters stand at a point where the individual can acquire the sure consciousness of achieving something truly perfect in the field of science only in case he is a strict specialist.

All work that overlaps neighboring fields, such as we occasionally undertake and which the sociologists must necessarily undertake again and again, is burdened with the resigned realization that at best one provides the specialist with useful questions upon which he would not so easily hit from his own specialized point of view. One's own work must inevitably remain highly imperfect. Only by strict specialization can the scientific worker become fully conscious, for once and perhaps never again in his lifetime, that he has achieved something that will endure. A really definitive and good accomplishment is today always a specialized accomplishment. And whoever lacks the capacity to put on blinders, so to speak, and to come up to the idea that the fate of his soul depends upon whether or not he makes the correct conjecture at this passage of this manuscript may as well stay away from science. He will never have what one may call the 'personal experience' of science. Without this strange intoxication, ridiculed by every outsider; without this passion, this 'thousands of years must pass before you enter into life and thousands more wait in silence'— according to whether or not you succeed in making this conjecture; without this, you have *no* calling for science and you should do something else. For nothing is worthy of man as man unless he can pursue it with passionate devotion.

* Reprinted with permission from the book *From Max Weber: Essays in Sociology*, translated, edited and with an introduction by H. H. Gerth and C. Wright Mills (New York: Oxford University Press, 1946), pp. 134-156. Translated from 'Wissenschaft als Beruf,' *Gesammelte Aufsaetze zur Wissenschaftslehre* (Tübingen, 1922), pp. 524-55. Originally a speech at Munich University, 1918, published in 1919 by Duncker & Humboldt, Munich.

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Yet it is a fact that no amount of such enthusiasm, however sincere and profound it may be, can compel a problem to yield scientific results. Certainly enthusiasm is a prerequisite of the 'inspiration' which is decisive. Nowadays in circles of youth there is a widespread notion that science has become a problem in calculation, fabricated in laboratories or statistical filing systems just as 'in a factory,' a calculation involving only the cool intellect and not one's 'heart and soul.' First of all one must say that such comments lack all clarity about what goes on in a factory or in a laboratory. In both some idea has to occur to someone's mind, and it has to be a correct idea, if one is to accomplish anything worthwhile. And such intuition cannot be forced. It has nothing to do with any cold calculation. Certainly calculation is also an indispensable prerequisite. No sociologist, for instance, should think himself too good, even in his old age, to make tens of thousands of quite trivial computations in his head and perhaps for months at a time. One cannot with impunity try to transfer this task entirely to mechanical assistants if one wishes to figure something, even though the final result is often small indeed. But if no 'idea' occurs to his mind about the direction of his computations and, during his computations, about the bearing of the emergent single results, then even this small result will not be yielded.

Normally such an 'idea' is prepared only on the soil of very hard work, but certainly this is not always the case. Scientifically, a dilettante's idea may have the very same or even a greater bearing for science than that of a specialist. Many of our very best hypotheses and insights are due precisely to dilettantes. The dilettante differs from the expert, as Helmholtz has said of Robert Mayer, only in that he lacks a firm and reliable work procedure. Consequently he is usually not in the position to control, to estimate, or to exploit the idea in its bearings. The idea is not a substitute for work; and work, in turn, cannot substitute for or compel an idea, just as little as enthusiasm can. Both, enthusiasm and work, and above all both of them *jointly*, can entice the idea.

Ideas occur to us when they please, not when it pleases us. The best ideas do indeed occur to one's mind in the way in which Ihering describes it: when smoking a cigar on the sofa; or as Helmholtz states of himself with scientific exactitude: when taking a walk on a slowly ascending street; or in a similar way. In any case, ideas come when we do not expect them, and not when we are brooding

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and searching at our desks. Yet ideas would certainly not come to mind had we not brooded at our desks and searched for answers with passionate devotion.

However this may be, the scientific worker has to take into his bargain the risk that enters into all scientific work: Does an 'idea' occur or does it not? He may be an excellent worker and yet never have had any valuable idea of his own. It is a grave error to believe that this is so only in science, and that things for instance in a business office are different from a laboratory. A merchant or a big industrialist without 'business imagination,' that is, without ideas or ideal intuitions, will for all his life remain a man who would better have remained a clerk or a technical official. He will never be truly creative in organization. Inspiration in the field of science by no means plays any greater role, as academic conceit fancies, than it does in the field of mastering problems of practical life by a modern entrepreneur. On the other hand, and this also is often misconstrued, inspiration plays no less a role in science than it does in the realm of art. It is a childish notion to think that a mathematician attains any scientifically valuable results by sitting at his desk with a ruler, calculating machines or other mechanical means. The mathematical imagination of a Weierstrass is naturally quite differently oriented in meaning and result than is the imagination of an artist, and differs basically in quality. But the psychological processes do not differ. Both are frenzy (in the sense of Plato's 'mania') and 'inspiration.'

Now, whether we have scientific inspiration depends upon destinies that are hidden from us, and besides upon 'gifts.' Last but not least, because of this indubitable truth, a very understandable attitude has become popular, especially among youth, and has put them in the service of idols whose cult today occupies a broad place on all street corners and in all periodicals. These idols are 'personality' and 'personal experience.' Both are intimately connected, the notion prevails that the latter constitutes the former and belongs to it. People belabor themselves in trying to 'experience' life – for that befits a personality, conscious of its rank and station. And if we do not succeed in 'experiencing' life, we must at least pretend to have this gift of grace. Formerly we called this 'experience,' in plain German, 'sensation'; and I believe that we then had a more adequate idea of what personality is and what it signifies.

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Ladies and gentlemen. In the field of science only he who is devoted *solely* to the work at hand has 'personality.' And this holds not only for the field of science; we know of no great artist who has ever done anything but serve his work and only his work. As far as his art is concerned, even with a personality of Goethe's rank, it has been detrimental to take the liberty of trying to make his 'life' into a work of art. And even if one doubts this, one has to be a Goethe in order to dare permit oneself such liberty. Everybody will admit at least this much: that even with a man like Goethe, who appears once in a thousand years, this liberty did not go unpaid for. In politics matters are not different, but we shall not discuss that today. In the field of science, however, the man who makes himself the impresario of the subject to which he should be devoted, and steps upon the stage and seeks to legitimate himself through 'experience,' asking: How can I prove that I am something other than a mere 'specialist' and how can I manage to say something in form or in content that nobody else has ever said?—such a man is no 'personality.' Today such conduct is a crowd phenomenon, and it always makes a petty impression and debases the one who is thus concerned. Instead of this, an inner devotion to the task, and that alone, should lift the scientist to the height and dignity of the subject he pretends to serve. And in this it is not different with the artist.

In contrast with these preconditions which scientific work shares with art, science has a fate that profoundly distinguishes it from artistic work. Scientific work is chained to the course of progress; whereas in the realm of art there is no progress in the same sense. It is not true that the work of art of a period that has worked out new technical means, or, for instance, the laws of perspective, stands therefore artistically higher than a work of art devoid of all knowledge of those means and laws—if its form does justice to the material, that is, if its object has been chosen and formed so that it could be artistically mastered without applying those conditions and means. A work of art which is genuine 'fulfilment' is never surpassed; it will never be antiquated. Individuals may differ in appreciating the personal significance of works of art, but no one will ever be able to say of such a work that it is outstripped by another work which is also 'fulfilment.'

In science, each of us knows that what he has accomplished will be antiquated in ten, twenty, fifty years. That is the fate to which

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science is subjected; it is the very *meaning* of scientific work, to which it is devoted in a quite specific sense, as compared with other spheres of culture for which in general the same holds. Every scientific 'fulfilment' raises new 'questions'; it *asks* to be 'surpassed' and outdated. Whoever wishes to serve science has to resign himself to this fact. Scientific works certainly can last as 'gratifications' because of their artistic quality, or they may remain important as a means of training. Yet they will be surpassed scientifically – let that be repeated – for it is our common fate and, more, our common goal. We cannot work without hoping that others will advance further than we have. In principle, this progress goes on *ad infinitum*. And with this we come to inquire into the *meaning* of science. For, after all, it is not self-evident that something subordinate to such a law is sensible and meaningful in itself. Why does one engage in doing something that in reality never comes, and never can come, to an end?

One does it, first, for purely practical, in the broader sense of the word, for technical, purposes: in order to be able to orient our practical activities to the expectations that scientific experience places at our disposal. Good. Yet this has meaning only to practitioners. What is the attitude of the academic man towards his vocation – that is, if he is at all in quest of such a personal attitude? He maintains that he engages in 'science for science's sake' and not merely because others, by exploiting science, bring about commercial or technical success and can better feed, dress, illuminate, and govern. But what does he who allows himself to be integrated into this specialized organization, running on *ad infinitum*, hope to accomplish that is significant in these productions that are always destined to be outdated? This question requires a few general considerations.

Scientific progress is a fraction, the most important fraction, of the process of intellectualization which we have been undergoing for thousands of years and which nowadays is usually judged in such an extremely negative way. Let us first clarify what this intellectualist rationalization, created by science and by scientifically oriented technology, means practically.

Does it mean that we, today, for instance, everyone sitting in this hall, have a greater knowledge of the conditions of life under which we exist than has an American Indian or a Hottentot? Hardly. Unless he is a physicist, one who rides on the streetcar has no idea how the car happened to get into motion. And he does not need

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to know. He is satisfied that he may 'count' on the behavior of the streetcar, and he orients his conduct according to this expectation; but he knows nothing about what it takes to produce such a car so that it can move. The savage knows incomparably more about his tools. When we spend money today I bet that even if there are colleagues of political economy here in the hall, almost every one of them will hold a different answer in readiness to the question: How does it happen that one can buy something for money – sometimes more and sometimes less? The savage knows what he does in order to get his daily food and which institutions serve him in this pursuit. The increasing intellectualization and rationalization do *not,* therefore, indicate an increased and general knowledge of the conditions under which one lives.

It means something else, namely, the knowledge or belief that if one but wished one *could* learn it at any time. Hence, it means that principally there are no mysterious incalculable forces that come into play, but rather that one can, in principle, master all things by calculation. This means that the world is disenchanted. One need no longer have recourse to magical means in order to master or implore the spirits, as did the savage, for whom such mysterious powers existed. Technical means and calculations perform the service. This above all is what intellectualization means.

Now, this process of disenchantment, which has continued to exist in Occidental culture for millennia, and, in general, this 'progress,' to which science belongs as a link and motive force, do they have any meanings that go beyond the purely practical and technical? You will find this question raised in the most principled form in the works of Leo Tolstoi. He came to raise the question in a peculiar way. All his broodings increasingly revolved around the problem of whether or not death is a meaningful phenomenon. And his answer was: for civilized man death has no meaning. It has none because the individual life of civilized man, placed into an infinite 'progress,' according to its own immanent meaning should never come to an end; for there is always a further step ahead of one who stands in the march of progress. And no man who comes to die stands upon the peak which lies in infinity. Abraham, or some peasant of the past, died 'old and satiated with life' because he stood in the organic cycle of life; because his life, in terms of its meaning and on the eve of his days, had given to him what life had to offer; because for him there remained no

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puzzles he might wish to solve; and therefore he could have had 'enough' of life. Whereas civilized man, placed in the midst of the continuous enrichment of culture by ideas, knowledge, and problems, may become 'tired of life' but not 'satiated with life.' He catches only the most minute part of what the life of the spirit brings forth ever anew, and what he seizes is always something provisional and not definitive, and therefore death for him is a meaningless occurrence. And because death is meaningless, civilized life as such is meaningless; by its very 'progressiveness' it gives death the imprint of meaninglessness. Throughout his late novels one meets with this thought as the keynote of the Tolstoyan art.

What stand should one take? Has 'progress' as such a recognizable meaning that goes beyond the technical, so that to serve it is a meaningful vocation? The question must be raised. But this is no longer merely the question of man's calling *for* science, hence, the problem of what science as a vocation means to its devoted disciples. To raise this question is to ask for the vocation of science within the total life of humanity. What is the value of science?

Here the contrast between the past and the present is tremendous. You will recall the wonderful image at the beginning of the seventh book of Plato's *Republic:* those enchained cavemen whose faces are turned toward the stone wall before them. Behind them lies the source of the light which they cannot see. They are concerned only with the shadowy images that this light throws upon the wall, and they seek to fathom their interrelations. Finally one of them succeeds in shattering his fetters, turns around, and sees the sun. Blinded, he gropes about and stammers of what he saw. The others say he is raving. But gradually he learns to behold the light, and then his task is to descend to the cavemen and to lead them to the light. He is the philosopher; the sun, however, is the truth of science, which alone seizes not upon illusions and shadows but upon the true being.

Well, who today views science in such a manner? Today youth feels rather the reverse: the intellectual constructions of science constitute an unreal realm of artificial abstractions, which with their bony hands seek to grasp the blood-and-the-sap of true life without ever catching up with it. But here in life, in what for Plato was the play of shadows on the walls of the cave, genuine reality is pulsating; and the rest are derivatives of life, lifeless ghosts, and nothing else. How did this change come about?

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Plato's passionate enthusiasm in *The Republic* must, in the last analysis, be explained by the fact that for the first time the *concept*, one of the great tools of all scientific knowledge, had been consciously discovered. Socrates had discovered it in its bearing. He was not the only man in the world to discover it. In India one finds the beginnings of a logic that is quite similar to that of Aristotle's. But nowhere else do we find this realization of the significance of the concept. In Greece, for the first time, appeared a handy means by which one could put the logical screws upon somebody so that he could not come out without admitting either that he knew nothing or that this and nothing else was truth, the *eternal* truth that never would vanish as the doings of the blind men vanish. That was the tremendous experience which dawned upon the disciples of Socrates. And from this it seemed to follow that if one only found the right concept of the beautiful, the good, or, for instance, of bravery, of the soul – or whatever – that then one could also grasp its true being. And this, in turn, seemed to open the way for knowing and for teaching how to act rightly in life and, above all, how to act as a citizen of the state; for this question was everything to the Hellenic man, whose thinking was political throughout. And for these reasons one engaged in science.

The second great tool of scientific work, the rational experiment, made its appearance at the side of this discovery of the Hellenic spirit during the Renaissance period. The experiment is a means of reliably controlling experience. Without it, present-day empirical science would be impossible. There were experiments earlier; for instance, in India physiological experiments were made in the service of ascetic yoga technique; in Hellenic antiquity, mathematical experiments were made for purposes of war technology; and in the Middle Ages, for purposes of mining. But to raise the experiment to a principle of research was the achievement of the Renaissance. They were the great innovators in *art*, who were the pioneers of experiment. Leonardo and his like and, above all, the sixteenth-century experimenters in music with their experimental pianos were characteristic. From these circles the experiment entered science, especially through Galileo, and it entered theory through Bacon; and then it was taken over by the various exact disciplines of the continental universities, first of all those of Italy and then those of the Netherlands.

What did science mean to these men who stood at the threshold

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of modern times? To artistic experimenters of the type of Leonardo and the musical innovators, science meant the path to *true* art, and that meant for them the path to true *nature*. Art was to be raised to the rank of a science, and this meant at the same time and above all to raise the artist to the rank of the doctor, socially and with reference to the meaning of his life. This is the ambition on which, for instance, Leonardo's sketch book was based. And today? 'Science as the way to nature' would sound like blasphemy to youth. Today, youth proclaims the opposite: redemption from the intellectualism of science in order to return to one's own nature and therewith to nature in general. Science as a way to art? Here no criticism is even needed.

But during the period of the rise of the exact sciences one expected a great deal more. If you recall Swammerdam's statement, 'Here I bring you the proof of God's providence in the anatomy of a louse,' you will see what the scientific worker, influenced (indirectly) by Protestantism and Puritanism, conceived to be his task: to show the path to God. People no longer found this path among the philosophers, with their concepts and deductions. All pietist theology of the time, above all Spener, knew that God was not to be found along the road by which the Middle Ages had sought him. God is hidden, His ways are not our ways, His thoughts are not our thoughts. In the exact sciences, however, where one could physically grasp His works, one hoped to come upon the traces of what He planned for the world. And today? Who – aside from certain big children who are indeed found in the natural sciences – still believes that the findings of astronomy, biology, physics, or chemistry could teach us anything about the *meaning* of the world? If there is any such 'meaning,' along what road could one come upon its tracks? If these natural sciences lead to anything in this way, they are apt to make the belief that there is such a thing as the 'meaning' of the universe die out at its very roots.

And finally, science as a way 'to God'? Science, this specifically irreligious power? That science today is irreligious no one will doubt in his innermost being, even if he will not admit it to himself. Redemption from the rationalism and intellectualism of science is the fundamental presupposition of living in union with the divine. This, or something similar in meaning, is one of the fundamental watchwords one hears among German youth, whose feelings are attuned to religion or who crave religious experiences. They crave

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not only religious experience but experience as such. The only thing that is strange is the method that is now followed: the spheres of the irrational, the only spheres that intellectualism has not yet touched, are now raised into consciousness and put under its lens. For in practice this is where the modern intellectualist form of romantic irrationalism leads. This method of emancipation from intellectualism may well bring about the very opposite of what those who take to it conceive as its goal.

After Nietzsche's devastating criticism of those 'last men' who 'invented happiness,' I may leave aside altogether the naive optimism in which science – that is, the technique of mastering life which rests upon science – has been celebrated as the way to happiness. Who believes in this? – aside from a few big children in university chairs or editorial offices. Let us resume our argument.

Under these internal presuppositions, what is the meaning of science as a vocation, now after all these former illusions, the 'way to true being,' the 'way to true art,' the 'way to true nature,' the 'way to true God,' the 'way to true happiness,' have been dispelled? Tolstoi has given the simplest answer, with the words: 'Science is meaningless because it gives no answer to our question, the only question important for us: "What shall we do and how shall we live?"' That science does not give an answer to this is indisputable. The only question that remains is the sense in which science gives 'no' answer, and whether or not science might yet be of some use to the one who puts the question correctly.

Today one usually speaks of science as 'free from presuppositions.' Is there such a thing? It depends upon what one understands thereby. All scientific work presupposes that the rules of logic and method are valid; these are the general foundations of our orientation in the world; and, at least for our special question, these presuppositions are the least problematic aspect of science. Science further presupposes that what is yielded by scientific work is important in the sense that it is 'worth being known.' In this, obviously, are contained all our problems. For this presupposition cannot be proved by scientific means. It can only be *interpreted* with reference to its ultimate meaning, which we must reject or accept according to our ultimate position towards life.

Furthermore, the nature of the relationship of scientific work and its presuppositions varies widely according to their structure. The natural sciences, for instance, physics, chemistry, and astron-

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omy, presuppose as self-evident that it is worth while to know the ultimate laws of cosmic events as far as science can construe them. This is the case not only because with such knowledge one can attain technical results but for its own sake, if the quest for such knowledge is to be a 'vocation.' Yet this presupposition can by no means be proved. And still less can it be proved that the existence of the world which these sciences describe is worth while, that it has any 'meaning,' or that it makes sense to live in such a world. Science does not ask for the answers to such questions.

Consider modern medicine, a practical technology which is highly developed scientifically. The general 'presupposition' of the medical enterprise is stated trivially in the assertion that medical science has the task of maintaining life as such and of diminishing suffering as such to the greatest possible degree. Yet this is problematical. By his means the medical man preserves the life of the mortally ill man, even if the patient implores us to relieve him of life, even if his relatives, to whom his life is worthless and to whom the costs of maintaining his worthless life grow unbearable, grant his redemption from suffering. Perhaps a poor lunatic is involved, whose relatives, whether they admit it or not, wish and must wish for his death. Yet the presuppositions of medicine, and the penal code, prevent the physician from relinquishing his therapeutic efforts. Whether life is worth while living and when – this question is not asked by medicine. Natural science gives us an answer to the question of what we must do if we wish to master life technically. It leaves quite aside, or assumes for its purposes, whether we should and do wish to master life technically and whether it ultimately makes sense to do so.

Consider a discipline such as aesthetics. The fact that there are works of art is given for aesthetics. It seeks to find out under what conditions this fact exists, but it does not raise the question whether or not the realm of art is perhaps a realm of diabolical grandeur, a realm of this world, and therefore, in its core, hostile to God and, in its innermost and aristocratic spirit, hostile to the brotherhood of man. Hence, aesthetics does not ask whether there *should* be works of art.

Consider jurisprudence. It establishes what is valid according to the rules of juristic thought, which is partly bound by logically compelling and partly by conventionally given schemata. Juridical thought holds when certain legal rules and certain methods of in-

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terpretations are recognized as binding. Whether there should be law and whether one should establish just these rules – such questions jurisprudence does not answer. It can only state: If one wishes this result, according to the norms of our legal thought, this legal rule is the appropriate means of attaining it.

Consider the historical and cultural sciences. They teach us how to understand and interpret political, artistic, literary, and social phenomena in terms of their origins. But they give us no answer to the question, whether the existence of these cultural phenomena have been and are *worth while*. And they do not answer the further question, whether it is worth the effort required to know them. They presuppose that there is an interest in partaking, through this procedure, of the community of 'civilized men.' But they cannot prove 'scientifically' that this is the case; and that they presuppose this interest by no means proves that it goes without saying. In fact it is not at all self-evident.

Finally, let us consider the disciplines close to me: sociology, history, economics, political science, and those types of cultural philosophy that make it their task to interpret these sciences. It is said, and I agree, that politics is out of place in the lecture-room. It does not belong there on the part of the students. If, for instance, in the lecture-room of my former colleague Dietrich Schäfer in Berlin, pacifist students were to surround his desk and make an uproar, I should deplore it just as much as I should deplore the uproar which anti-pacifist students are said to have made against Professor Förster, whose views in many ways are as remote as could be from mine. Neither does politics, however, belong in the lecture-room on the part of the docents, and when the docent is scientifically concerned with politics, it belongs there least of all.

To take a practical political stand is one thing, and to analyze political structures and party positions is another. When speaking in a political meeting about democracy, one does not hide one's personal standpoint; indeed, to come out clearly and take a stand is one's damned duty. The words one uses in such a meeting are not means of scientific analysis but means of canvassing votes and winning over others. They are not plowshares to loosen the soil of contemplative thought; they are swords against the enemies: such words are weapons. It would be an outrage, however, to use words in this fashion in a lecture or in the lecture-room. If, for instance, 'democracy' is under discussion, one considers its various

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forms, analyzes them in the way they function, determines what results for the conditions of life the one form has as compared with the other. Then one confronts the forms of democracy with non-democratic forms of political order and endeavors to come to a position where the student may find the point from which, in terms of his ultimate ideals, he can take a stand. But the true teacher will beware of imposing from the platform any political position upon the student, whether it is expressed or suggested. 'To let the facts speak for themselves' is the most unfair way of putting over a political position to the student.

Why should we abstain from doing this? I state in advance that some highly esteemed colleagues are of the opinion that it is not possible to carry through this self-restraint and that, even if it were possible, it would be a whim to avoid declaring oneself. Now one cannot demonstrate scientifically what the duty of an academic teacher is. One can only demand of the teacher that he have the intellectual integrity to see that it is one thing to state facts, to determine mathematical or logical relations or the internal structure of cultural values, while it is another thing to answer questions of the *value* of culture and its individual contents and the question of how one should act in the cultural community and in political associations. These are quite heterogeneous problems. If he asks further why he should not deal with both types of problems in the lecture-room, the answer is: because the prophet and the demagogue do not belong on the academic platform.

To the prophet and the demagogue, it is said: 'Go your ways out into the streets and speak openly to the world,' that is, speak where criticism is possible. In the lecture-room we stand opposite our audience, and it has to remain silent. I deem it irresponsible to exploit the circumstance that for the sake of their career the students have to attend a teacher's course while there is nobody present to oppose him with criticism. The task of the teacher is to serve the students with his knowledge and scientific experience and not to imprint upon them his personal political views. It is certainly possible that the individual teacher will not entirely succeed in eliminating his personal sympathies. He is then exposed to the sharpest criticism in the forum of his own conscience. And this deficiency does not prove anything; other errors are also possible, for instance, erroneous statements of fact, and yet they prove nothing against the duty of searching for the truth. I also

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reject this in the very interest of science. I am ready to prove from the works of our historians that whenever the man of science introduces his personal value judgment, a full understanding of the facts *ceases*. But this goes beyond tonight's topic and would require lengthy elucidation.

I ask only: How should a devout Catholic, on the one hand, and a Freemason, on the other, in a course on the forms of church and state or on religious history ever be brought to evaluate these subjects alike? This is out of the question. And yet the academic teacher must desire and must demand of himself to serve the one as well as the other by his knowledge and methods. Now you will rightly say that the devout Catholic will never accept the view of the factors operative in bringing about Christianity which a teacher who is free of his dogmatic presuppositions presents to him. Certainly! The difference, however, lies in the following: Science 'free from presuppositions,' in the sense of a rejection of religious bonds, does not know of the 'miracle' and the 'revelation.' If it did, science would be unfaithful to its own 'presuppositions.' The believer knows both, miracle and revelation. And science 'free from presuppositions' expects from him no less – and no more – than acknowledgment that *if* the process can be explained without those supernatural interventions, which an empirical explanation has to eliminate as causal factors, the process has to be explained the way science attempts to do. And the believer can do this without being disloyal to his faith.

But has the contribution of science no meaning at all for a man who does not care to know facts as such and to whom only the practical standpoint matters? Perhaps science nevertheless contributes something.

The primary task of a useful teacher is to teach his students to recognize 'inconvenient' facts – I mean facts that are inconvenient for their party opinions. And for every party opinion there are facts that are extremely inconvenient, for my own opinion no less than for others. I believe the teacher accomplishes more than a mere intellectual task if he compels his audience to accustom itself to the existence of such facts. I would be so immodest as even to apply the expression 'moral achievement,' though perhaps this may sound too grandiose for something that should go without saying.

Thus far I have spoken only of practical reasons for avoiding the imposition of a personal point of view. But these are not the

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only reasons. The impossibility of 'scientifically' pleading for practical and interested stands – except in discussing the means for a firmly given and presupposed end – rests upon reasons that lie far deeper.

'Scientific' pleading is meaningless in principle because the various value spheres of the world stand in irreconcilable conflict with each other. The elder Mill, whose philosophy I will not praise otherwise, was on this point right when he said: If one proceeds from pure experience, one arrives at polytheism. This is shallow in formulation and sounds paradoxical, and yet there is truth in it. If anything, we realize again today that something can be sacred not only in spite of its not being beautiful, but rather because and in so far as it is not beautiful. You will find this documented in the fifty-third chapter of the book of Isaiah and in the twenty-first Psalm. And, since Nietzsche, we realize that something can be beautiful, not only in spite of the aspect in which it is not good, but rather in that very aspect. You will find this expressed earlier in the *Fleurs du mal,* as Baudelaire named his volume of poems. It is commonplace to observe that something may be true although it is not beautiful and not holy and not good. Indeed it may be true in precisely those aspects. But all these are only the most elementary cases of the struggle that the gods of the various orders and values are engaged in. I do not know how one might wish to decide 'scientifically' the value of French and German culture; for here, too, different gods struggle with one another, now and for all times to come.

We live as did the ancients when their world was not yet disenchanted of its gods and demons, only we live in a different sense. As Hellenic man at times sacrificed to Aphrodite and at other times to Apollo, and, above all, as everybody sacrificed to the gods of his city, so do we still nowadays, only the bearing of man has been disenchanted and denuded of its mystical but inwardly genuine plasticity. Fate, and certainly not 'science,' holds sway over these gods and their struggles. One can only understand what the godhead is for the one order or for the other, or better, what godhead is in the one or in the other order. With this understanding, however, the matter has reached its limit so far as it can be discussed in a lecture-room and by a professor. Yet the great and vital problem that is contained therein is, of course, very far from being concluded. But forces other than university chairs have their say in this matter.

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What man will take upon himself the attempt to 'refute scientifically' the ethic of the Sermon on the Mount? For instance, the sentence, 'resist no evil,' or the image of turning the other cheek? And yet it is clear, in mundane perspective, that this is an ethic of undignified conduct; one has to choose between the religious dignity which this ethic confers and the dignity of manly conduct which preaches something quite different; 'resist evil – lest you be co-responsible for an overpowering evil.' According to our ultimate standpoint, the one is the devil and the other the God, and the individual has to decide which is God for him and which is the devil. And so it goes throughout all the orders of life.

The grandiose rationalism of an ethical and methodical conduct of life which flows from every religious prophecy has dethroned this polytheism in favor of the 'one thing that is needful.' Faced with the realities of outer and inner life, Christianity has deemed it necessary to make those compromises and relative judgments, which we all know from its history. Today the routines of everyday life challenge religion. Many old gods ascend from their graves; they are disenchanted and hence take the form of impersonal forces. They strive to gain power over our lives and again they resume their eternal struggle with one another. What is hard for modern man, and especially for the younger generation, is to measure up to *workaday* existence. The ubiquitous chase for 'experience' stems from this weakness; for it is weakness not to be able to countenance the stern seriousness of our fateful times.

Our civilization destines us to realize more clearly these struggles again, after our eyes have been blinded for a thousand years – blinded by the allegedly or presumably exclusive orientation towards the grandiose moral fervor of Christian ethics.

But enough of these questions which lead far away. Those of our youth are in error who react to all this by saying, 'Yes, but we happen to come to lectures in order to experience something more than mere analyses and statements of fact.' The error is that they seek in the professor something different from what stands before them. They crave a leader and not a teacher. But we are placed upon the platform solely as teachers. And these are two different things, as one can readily see. Permit me to take you once more to America, because there one can often observe such matters in their most massive and original shape.

The American boy learns unspeakably less than the German boy.

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In spite of an incredible number of examinations, his school life has not had the significance of turning him into an absolute creature of examinations, such as the German. For in America, bureaucracy, which presupposes the examination diploma as a ticket of admission to the realm of office prebends, is only in its beginnings. The young American has no respect for anything or anybody, for tradition or for public office – unless it is for the personal achievement of individual men. This is what the American calls 'democracy.' This is the meaning of democracy, however distorted its intent may in reality be, and this intent is what matters here. The American's conception of the teacher who faces him is: he sells me his knowledge and his methods for my father's money, just as the greengrocer sells my mother cabbage. And that is all. To be sure, *if the teacher happens to be a football coach, then, in this field,* he is a leader. But if he is not this (or something similar in a different field of sports), he is simply a teacher and nothing more. And no young American would think of having the teacher sell him a *Weltanschauung* or a code of conduct. Now, when formulated in this manner, we should reject this. But the question is whether there is not a grain of salt contained in this feeling, which I have deliberately stated in extreme with some exaggeration.

Fellow students! You come to our lectures and demand from us the qualities of leadership, and you fail to realize in advance that of a hundred professors at least ninety-nine do not and must not claim to be football masters in the vital problems of life, or even to be 'leaders' in matters of conduct. Please, consider that a man's value does not depend on whether or not he has leadership qualities. And in any case, the qualities that make a man an excellent scholar and academic teacher are not the qualities that make him a leader to give direction in practical life or, more specifically, in politics. It is pure accident if a teacher also possesses this quality, and it is a critical situation if every teacher on the platform feels himself confronted with the students' expectation that the teacher should claim this quality. It is still more critical if it is left to every academic teacher to set himself up as a leader in the lecture-room. For those who most frequently think of themselves as leaders often qualify least as leaders. But irrespective of whether they are or are not, the platform situation simply offers no possibility of *proving* themselves to be leaders. The professor who feels called upon to act as a counselor of youth and enjoys their

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trust may prove himself a man in personal human relations with them. And if he feels called upon to intervene in the struggles of world views and party opinions, he may do so outside, in the market place, in the press, in meetings, in associations, wherever he wishes. But after all, it is somewhat too convenient to demonstrate one's courage in taking a stand where the audience and possible opponents are condemned to silence.

Finally, you will put the question: 'If this is so, what then does science actually and positively contribute to practical and personal "life"?' Therewith we are back again at the problem of science as a 'vocation.'

First, of course, science contributes to the technology of controlling life by calculating external objects as well as man's activities. Well, you will say, that, after all, amounts to no more than the greengrocer of the American boy. I fully agree.

Second, science can contribute something that the greengrocer cannot: methods of thinking, the tools and the training for thought. Perhaps you will say: well, that is no vegetable, but it amounts to no more than the means for procuring vegetables. Well and good, let us leave it at that for today.

Fortunately, however, the contribution of science does not reach its limit with this. We are in a position to help you to a third objective: to gain *clarity*. Of course, it is presupposed that we ourselves possess clarity. As far as this is the case, we can make clear to you the following:

In practice, you can take this or that position when concerned with a problem of value – for simplicity's sake, please think of social phenomena as examples. *If* you take such and such a stand, then, according to scientific experience, you have to use such and such a *means* in order to carry out your conviction practically. Now, these means are perhaps such that you believe you must reject them. Then you simply must choose between the end and the inevitable means. Does the end 'justify' the means? Or does it not? The teacher can confront you with the necessity of this choice. He cannot do more, so long as he wishes to remain a teacher and not to become a demagogue. He can, of course, also tell you that if you want such and such an end, then you must take into the bargain the subsidiary consequences which according to all experience will occur. Again we find ourselves in the same situation as before. These are still problems that can also emerge

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for the technician, who in numerous instances has to make decisions according to the principle of the lesser evil or of the relatively best. Only to him one thing, the main thing, is usually given, namely, the end. But as soon as truly 'ultimate' problems are at stake for us this is not the case. With this, at long last, we come to the final service that science as such can render to the aim of clarity, and at the same time we come to the limits of science.

Besides we can and we should state: In terms of its meaning, such and such a practical stand can be derived with inner consistency, and hence integrity, from this or that ultimate *weltanschauliche* position. Perhaps it can only be derived from one such fundamental position, or maybe from several, but it cannot be derived from these or those other positions. Figuratively speaking, you serve this god and you offend the other god when you decide to adhere to this position. And if you remain faithful to yourself, you will necessarily come to certain final conclusions that subjectively make sense. This much, in principle at least, can be accomplished. Philosophy, as a special discipline, and the essentially philosophical discussions of principles in the other sciences attempt to achieve this. Thus, if we are competent in our pursuit (which must be presupposed here) we can force the individual, or at least we can help him, to give himself an *account of the ultimate meaning of his own conduct.* This appears to me as not so trifling a thing to do, even for one's own personal life. Again, I am tempted to say of a teacher who succeeds in this: he stands in the service of 'moral' forces; he fulfils the duty of bringing about self-clarification and a sense of responsibility. And I believe he will be the more able to accomplish this, the more conscientiously he avoids the desire personally to impose upon or suggest to his audience his own stand.

This proposition, which I present here, always takes its point of departure from the one fundamental fact, that so long as life remains immanent and is interpreted in its own terms, it knows only of an unceasing struggle of these gods with one another. Or speaking directly, the ultimately possible attitudes toward life are irreconcilable, and hence their struggle can never be brought to a final conclusion. Thus it is necessary to make a decisive choice. Whether, under such conditions, science is a worth while 'vocation' for somebody, and whether science itself has an objectively valuable 'vocation' are again value judgments about which nothing

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can be said in the lecture-room. To affirm the value of science is a presupposition for teaching there. I personally by my very work answer in the affirmative, and I also do so from precisely the standpoint that hates intellectualism as the worst devil, as youth does today, or usually only fancies it does. In that case the word holds for these youths: 'Mind you, the devil is old; grow old to understand him.' This does not mean age in the sense of the birth certificate. It means that if one wishes to settle with this devil, one must not take to flight before him as so many like to do nowadays. First of all, one has to see the devil's ways to the end in order to realize his power and his limitations.

Science today is a 'vocation' organized in special disciplines in the service of self-clarification and knowledge of interrelated facts. It is not the gift of grace of seers and prophets dispensing sacred values and revelations, nor does it partake of the contemplation of sages and philosophers about the meaning of the universe. This, to be sure, is the inescapable condition of our historical situation. We cannot evade it so long as we remain true to ourselves. And if Tolstoi's question recurs to you: as science does not, who is to answer the question: 'What shall we do, and, how shall we arrange our lives?' or, in the words used here tonight: 'Which of the warring gods should we serve? Or should we serve perhaps an entirely different god, and who is he?' then one can say that only a prophet or a savior can give the answers. If there is no such man, or if his message is no longer believed in, then you will certainly not compel him to appear on this earth by having thousands of professors, as privileged hirelings of the state, attempt as petty prophets in their lecture-rooms to take over his role. All they will accomplish is to show that they are unaware of the decisive state of affairs: the prophet for whom so many of our younger generation yearn simply does not exist. But this knowledge in its forceful significance has never become vital for them. The inward interest of a truly religiously 'musical' man can never be served by veiling to him and to others the fundamental fact that he is destined to live in a godless and prophetless time by giving him the *ersatz* of armchair prophecy. The integrity of his religious organ, it seems to me, must rebel against this.

Now you will be inclined to say: Which stand does one take towards the factual existence of 'theology' and its claims to be a 'science'? Let us not flinch and evade the answer. To be sure,

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'theology' and 'dogmas' do not exist universally, but neither do they exist for Christianity alone. Rather (going backward in time), they exist in highly developed form also in Islam, in Manicheanism, in Gnosticism, in Orphism, in Parsism, in Buddhism, in the Hindu sects, in Taoism, and in the Upanishads, and, of course, in Judaism. To be sure their systematic development varies greatly. It is no accident that Occidental Christianity – in contrast to the theological possessions of Jewry – has expanded and elaborated theology more systematically, or strives to do so. In the Occident the development of theology has had by far the greatest historical significance. This is the product of the Hellenic spirit, and all theology of the West goes back to it, as (obviously) all theology of the East goes back to Indian thought. All theology represents an intellectual *rationalization* of the possession of sacred values. No science is absolutely free from presuppositions, and no science can prove its fundamental value to the man who rejects these presuppositions. Every theology, however, adds a few specific presuppositions for its work and thus for the justification of its existence. Their meaning and scope vary. Every theology, including for instance Hinduist theology, presupposes that the world must have a *meaning*, and the question is how to interpret this meaning so that it is intellectually conceivable.

It is the same as with Kant's epistemology. He took for his point of departure the presupposition: 'Scientific truth exists and it is valid,' and then asked: 'Under which presuppositions of thought is truth possible and meaningful?' The modern aestheticians (actually or expressly, as for instance, G. v. Lukacs) proceed from the presupposition that 'works of art exist,' and then ask: 'How is their existence meaningful and possible?'

As a rule, theologies, however, do not content themselves with this (essentially religious and philosophical) presupposition. They regularly proceed from the further presupposition that certain 'revelations' are facts relevant for salvation and as such make possible a meaningful conduct of life. Hence, these revelations must be believed in. Moreover, theologies presuppose that certain subjective states and acts possess the quality of holiness, that is, they constitute a way of life, or at least elements of one, that is religiously meaningful. Then the question of theology is: How can these presuppositions, which must simply be accepted, be meaningfully interpreted in a view of the universe? For theology,

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these presuppositions as such lie beyond the limits of 'science.' They do not represent 'knowledge,' in the usual sense, but rather a 'possession.' Whoever does not 'possess' faith, or the other holy states, cannot have theology as a substitute for them, least of all any other science. On the contrary, in every 'positive' theology, the devout reaches the point where the Augustinian sentence holds: *credo non quod, sed quia absurdum est.*

The capacity for the accomplishment of religious virtuosos – the 'intellectual sacrifice'– is the decisive characteristic of the positively religious man. That this is so is shown by the fact that in spite (or rather in consequence) of theology (which unveils it) the tension between the value-spheres of 'science' and the sphere of 'the holy' is unbridgeable. Legitimately, only the disciple offers the 'intellectual sacrifice' to the prophet, the believer to the church. Never as yet has a new prophecy emerged (and I repeat here deliberately this image which has offended some) by way of the need of some modern intellectuals to furnish their souls with, so to speak, guaranteed genuine antiques. In doing so, they happen to remember that religion has belonged among such antiques, and of all things religion is what they do not possess. By way of substitute, however, they play at decorating a sort of domestic chapel with small sacred images from all over the world, or they produce surrogates through all sorts of psychic experiences to which they ascribe the dignity of mystic holiness, which they peddle in the book market. This is plain humbug or self-deception. It is, however, no humbug but rather something very sincere and genuine if some of the youth groups who during recent years have quietly grown together give their human community the interpretation of a religious, cosmic, or mystical relation, although occasionally perhaps such interpretation rests on misunderstanding of self. True as it is that every act of genuine brotherliness may be linked with the awareness that it contributes something imperishable to a super-personal realm, it seems to me dubious whether the dignity of purely human and communal relations is enhanced by these religious interpretations. But that is no longer our theme.

The fate of our times is characterized by rationalization and intellectualization and, above all, by the 'disenchantment of the world.' Precisely the ultimate and most sublime values have retreated from public life either into the transcendental realm of mystic life or into the brotherliness of direct and personal human relations. It is

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not accidental that our greatest art is intimate and not monumental, nor is it accidental that today only within the smallest and intimate circles, in personal human situations, in *pianissimo*, that something is pulsating that corresponds to the prophetic *pneuma*, which in former times swept through the great communities like a firebrand, welding them together. If we attempt to force and to 'invent' a momumental style in art, such miserable monstrosities are produced as the many monuments of the last twenty years. If one tries intellectually to construe new religions without a new and genuine prophecy, then, in an inner sense, something similar will result, but with still worse effects. And academic prophecy, finally, will create only fanatical sects but never a genuine community.

To the person who cannot bear the fate of the times like a man, one must say: may he rather return silently, without the usual publicity build-up of renegades, but simply and plainly. The arms of the old churches are opened widely and compassionately for him. After all, they do not make it hard for him. One way or another he has to bring his 'intellectual sacrifice'—that is inevitable. If he can really do it, we shall not rebuke him. For such an intellectual sacrifice in favor of an unconditional religious devotion is ethically quite a different matter than the evasion of the plain duty of intellectual integrity, which sets in if one lacks the courage to clarify one's own ultimate standpoint and rather facilitates this duty by feeble relative judgments. In my eyes, such religious return stands higher than the academic prophecy, which does not clearly realize that in the lecture-rooms of the university no other virtue holds but plain intellectual integrity. Integrity, however, compels us to state that for the many who today tarry for new prophets and saviors, the situation is the same as resounds in the beautiful Edomite watchman's song of the period of exile that has been included among Isaiah's oracles:

> He calleth to me out of Seir, Watchman, what of the night? The watchman said, The morning cometh, and also the night: if ye will enquire, enquire ye: return, come.

The people to whom this was said has enquired and tarried for more than two millennia, and we are shaken when we realize its fate. From this we want to draw the lesson that nothing is gained by yearning and tarrying alone, and we shall act differently. We shall set to work and meet the 'demands of the day,' in human relations as well as in our vocation. This, however, is plain and simple, if each finds and obeys the demon who holds the fibers of his very life.

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NOTES FROM THE ACADEMY

On the Nature of the Unity We Seek*

KIRTLEY F. MATHER

WHEN first incorporated, in 1780, the American Academy of Arts and Sciences was composed of sixty-two Fellows who were "severally proficient" in practically every existing area of intellectual endeavor. The "end and design" of the infant institution, as set forth in its Charter, was "to cultivate every art and science." There seems to have been no thought that such a purpose was too diffuse to be realistic. Regardless of whatever diversity of interest and activity there must have been within that group of learned men, there was evidently a common allegiance to the search for knowledge and understanding, an effective spirit of inherent unity. Real fellowship was not only possible, but sufficiently operative to bind them all together into "a body politic and corporate."

Conditions have changed drastically since then. Both the vast expansion of knowledge and the increased complexity of life in a technological culture have made necessary more and more specialization on the part of men of genius and learning. Still all-inclusive in its structure, the Academy today is well-nigh unique among the thousands of learned societies, most of them highly specialized, that flourish today. In many of our colleges and universities, the ancient and honorable settee of natural philosophy has long since been broken apart to construct chairs of physics, chemistry, astronomy, geology and biology. More recently these chairs have been splintered to make footstools of hydrodynamics, chromatography, radio-astronomy, geomorphology, and so on.

Such specialization was inevitable. It is good. It is here to stay. But specialization brings fragmentation in its train. The world of scholarship is today a fractured world. Such phrases as "the fellowship of educated men" or "the community of scholars" are glibly mouthed during commencement exercises or other academic convocations, but most of us know that they bear little resemblance to reality. Rare indeed are the social psychologists, the nuclear physi-

*Based upon a communication presented at the 1400th Stated Meeting of the Academy, October 9, 1957.

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cists, and the musicologists who can even begin to understand each other's language when attempting to converse about their special disciplines.

In this situation it may well be that an effort to restore the sense of common purpose that motivated its founders and to provide an environment in which true community of spirit may undergird a real fellowship of "men of genius and learning" should be one of the most important functions of the Academy. If so, what is the nature of the unity thus to be sought?

One clue may be found in the Charter of our Academy itself. A common acceptance of social responsibility is clearly implied in the qualification of the otherwise unlimited phrase *every art and science*. It was not merely the quest for knowledge for its own sake purely, or for understanding simply for the joy that understanding brings, which drew the founders of the Academy together. It was the commitment "to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people." It is even so today. No matter how far apart the search for knowledge and understanding may take the devotees of that search, they may be brought together again by the unifying purpose of contributing to human welfare.

Such motivation impels the specialist to think occasionally in terms of wholes rather than of parts. How does the modicum of knowledge or understanding he has gained fit into the broader scheme of things? What are the relations between his work and that of others, even of others far distant along the expanding periphery of the known and understood? Analysis thus is followed by integration, if not by synthesis. A shining virtue of an all-inclusive academy, like that of a democratic society, is the unity that transcends and embraces diversity without demanding conformity.

Even so, it is unlikely that such a unifying purpose alone can provide a sufficiently strong cement to bind an aggregate of freewheeling, wide-ranging academicians into an inherently fruitful, effectively influential unit of society. The knowledge and understanding they possess and seek must itself be integrated in a meaningful and elegant way, regardless of its usefulness.

Integration of the abundant, widely diversified, fragments of knowledge now available among the many, more or less disparate, academic disciplines may be achieved in several ways. Workers in one area may use tools and techniques developed in a wholly different

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field of activity. Thus a geologist may acquire apparatus perfected by electronic engineers or by physicists concerned with the elastic properties of solids; and, using this to probe the secrets of the subsurface structure of the earth, he becomes a geophysicist. Thus, also, the radioisotopes created and isolated by nuclear chemists are used as tracers in many fields of research, ranging from medicine to metallurgy and beyond.

Or, again, a team of researchers drawn from diverse disciplines may be brought together to pool their knowledge and their techniques as they focus attention from many points of view upon some common problem. The increasing number of "centers" in institutions of higher learning for the study of a particular region, such as the Middle East, or of a particular environment, such as arid lands, is indicative of the fruitfulness of the research team as compared with that of research prosecuted by solitary individuals. The coordination of the work of thousands of individuals drawn from many academic disciplines in many countries, within the program of the International Geophysical Year, is of course a prime example.

Such interdisciplinary and multidisciplinary activities, at least in the sciences and social studies, are almost certain to promote a sense of unity among their participants. Ideally, if not actually in every instance, the members of such teams will argue one with another and even tear one another apart with the friendliest of motives. Factual data, successful techniques and fruitful perceptions not only are shared across the artificial boundaries of the separate disciplines, but also are coordinated and integrated to yield creative insights of far-reaching magnitude.

An all-inclusive institution, such as the Academy, does well to encourage and nourish multidisciplinary activities, not only because of their inherent value but also because of the contribution they may make toward the strengthening of the spirit of unity among its own members. Even more, such an institution should take advantage of every opportunity to provide occasions for informal contacts among its members in situations conducive to intellectual intercourse. Men of intelligence and good will are likely to find ways to surmount even the obdurate barriers of technical jargon and discover common interests and aims when they rub elbows with one another in an appropriate environment.

Even so, it is my opinion that the kind of unity we academicians ought to seek is more likely to be found by stressing the fundamental,

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integrating concepts at or near the roots of the tree of knowledge rather than by perfecting the multidisciplinary techniques that tie together the tips of the branches of that tree. The basic concepts that stimulate progress in every science and among all the arts often reveal elements of similarity that can scarcely be concealed by their superficial differences. The marching orders of a universe must presumably stem from some deep universal principle, underlying and potentially integrating the disparate systems that are discovered by, or revealed to, the minds and hearts of intelligent human beings. The quest for understanding of the most fundamental concepts concerning the nature of the universe and the meaning of life is the most potent of all the unifying processes, even though the final answers may forever elude us.

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